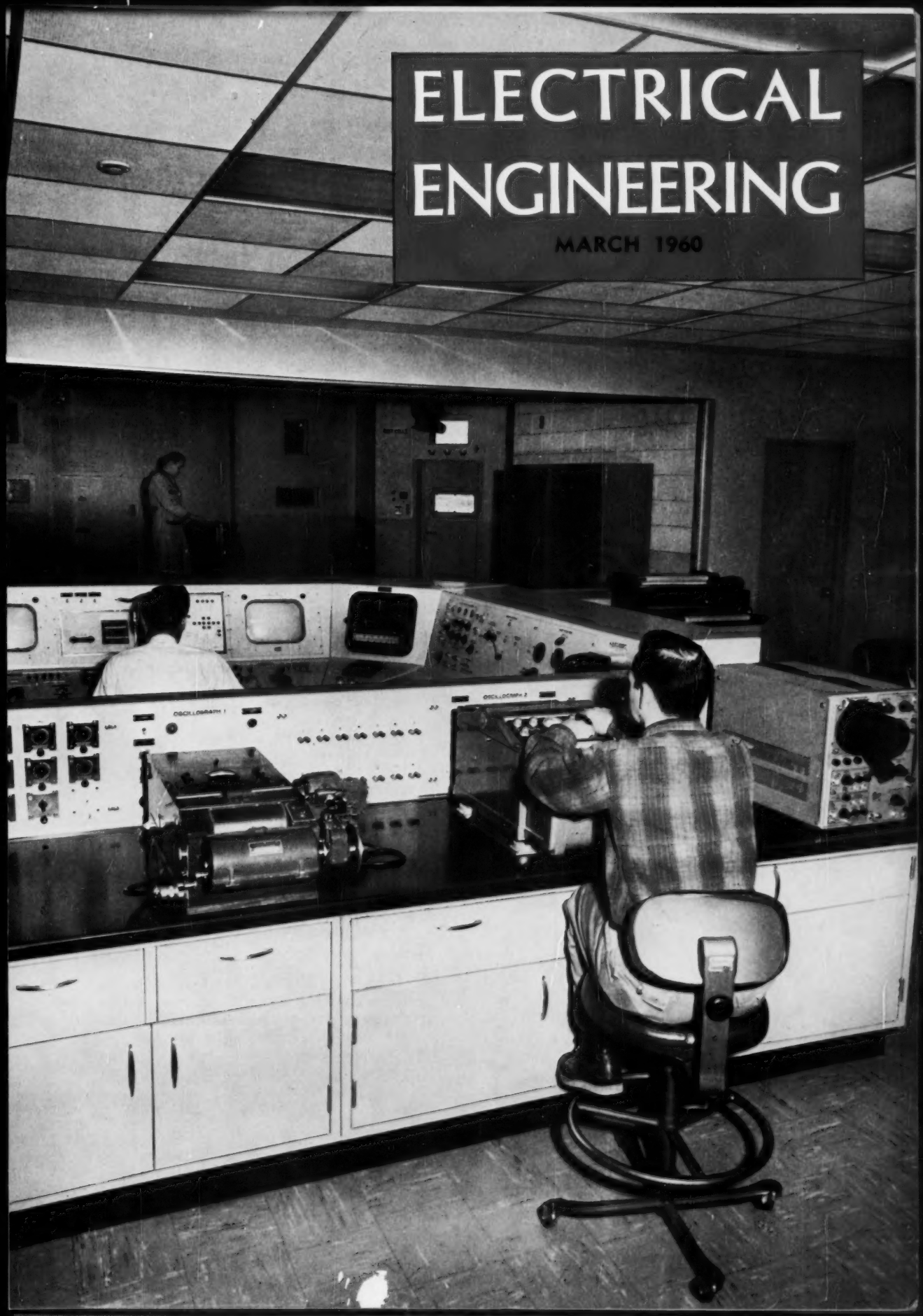
ELECTRICAL
ENGINEERING
MARCH 1960

the KUHLMAN 60

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The transformer bushing that reduces radio noise without oil

The new Kuhlman "Quick Grip" H. V. bushing offers revolutionary, positive reduction of radio interference. No oil is needed even at higher voltages. The bushing shank fits into a stress relieving ground sleeve normally used only with power transformer bushings. The sleeve's surface prevents any concentration of stresses that could cause radio noise.

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ELECTRICAL ENGINEERING

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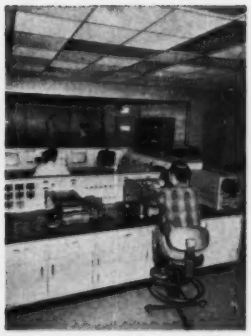

THE COVER: Closed-circuit television is used for monitoring tests of apparatus in the Short-Circuit Laboratory of Line Material Industries. One camera scans the test cells from outside the building, whereas a second camera is at the viewing port of No. 3 test cell. The engineer who controls the tests is seated before the screens and a technician at the oscillographs. Story on p. 196.

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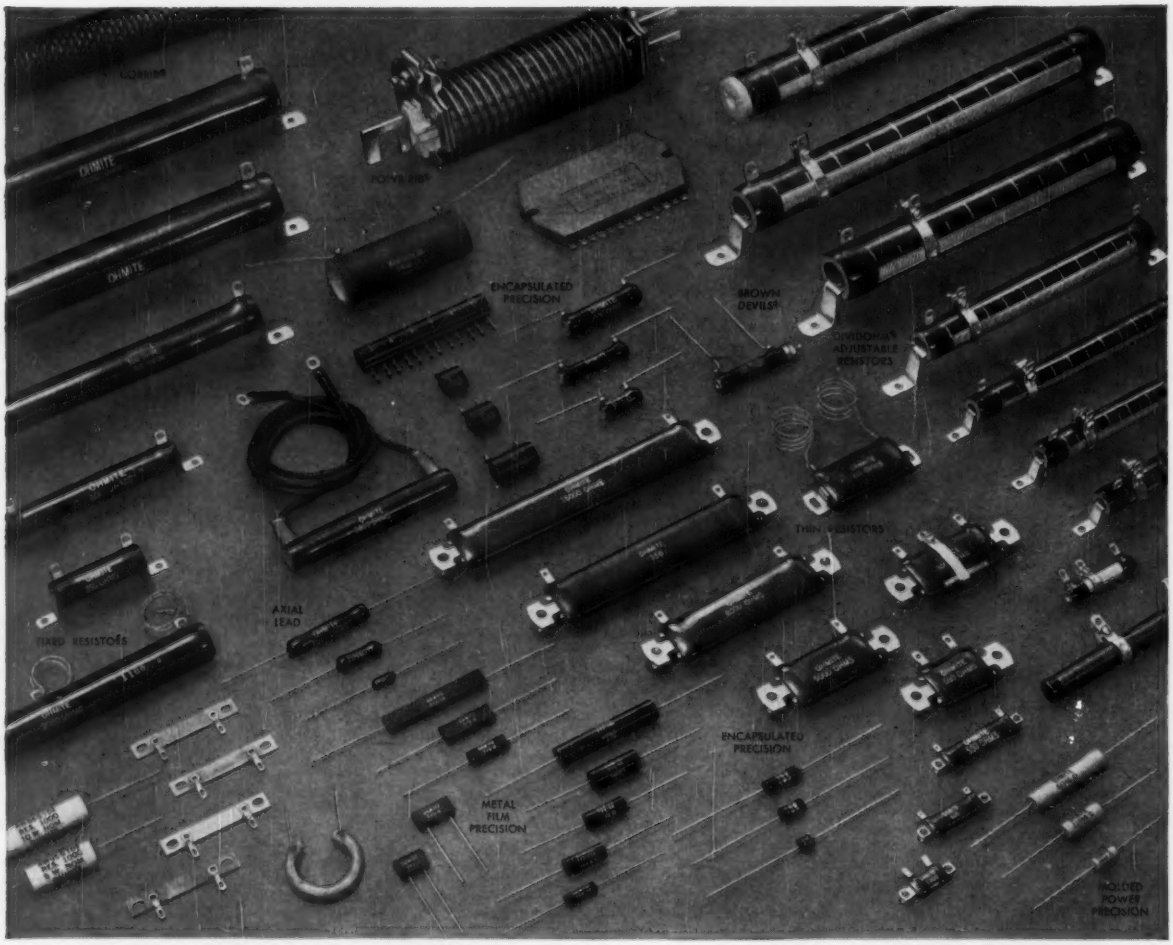

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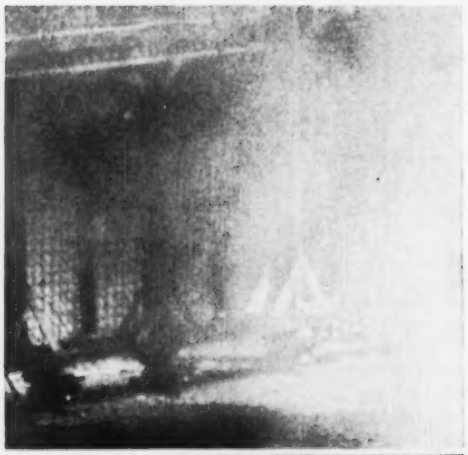

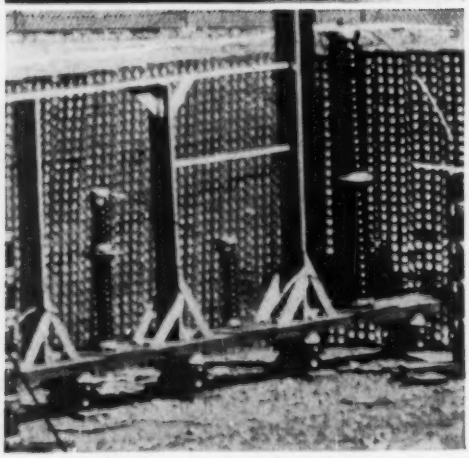

Frames from a high speed motion picture showing, successively: venting of gas through the Thorex pressure-relief system at the instant of fault current initiation, clearing of smoke and dust cloud, and the intact housing (far-right) after the test was completed.

Thorex arrester on pressure-relief test survives massive fault current...intact!

Output of several 230-kv transmission lines was added to 75 per cent of the total capacity of one of the country's largest hydro plants to produce the massive fault current used in this test of Thorex arrester internal pressure relief.

Station Class Thorex Type MPR arresters, with internal parts damaged to assure failure, were subjected to a symmetrical rms current of 23,000 amperes which, with offset, gave a 43,500-ampere crest. These arrester housings survived this fault current with all parts completely intact.

Factors contributing to this are (A) Pressure-relief diaphragms, at both ends, larger than the internal diameter of the arrester housing. (B) Direct-acting relief provisions, sensitive to *pressure only*, and functioning in an instantaneous single step. (C) A clear internal path of generous size, not impeded by any circuit parts, passes the rapidly traveling pressure front to the relief diaphragms.

There may come a time when an arrester is expected to fail. When that happens, its ability to remain physically intact can save costly damage to surrounding equipment. Thorex Dynagap Type MPR Station Class arresters have generous safety provisions for such an emergency, demonstrated by severe field testing.

Here is just one more of the many proven reasons why you should specify Thorex Dynagap lightning arresters on your next station construction.

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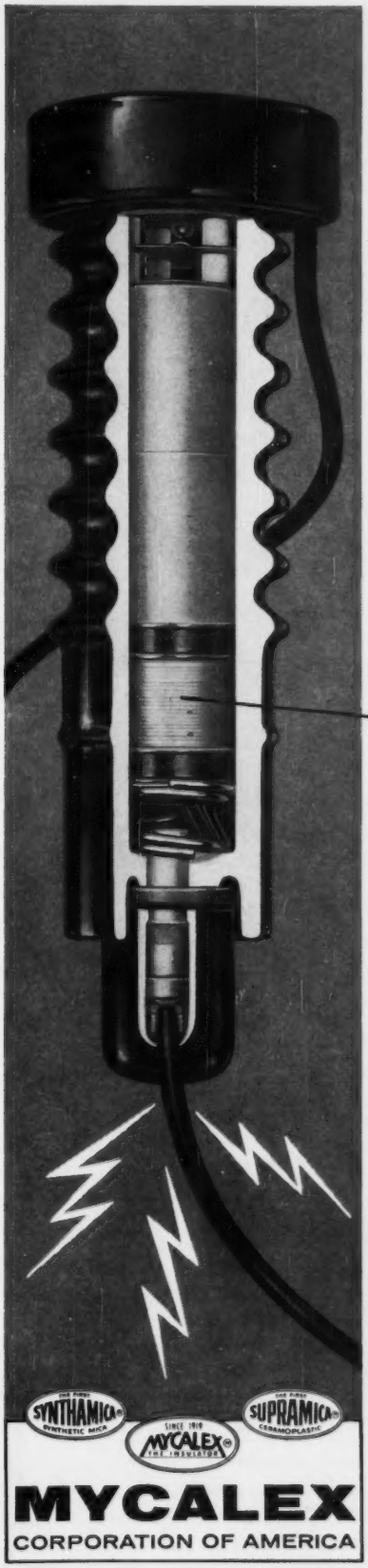

MYCALEX® 410 glass-bonded mica

from the family of the world's most nearly perfect insulation

helps THOREX arresters control the power of lightning!

These small, close tolerance plates have the ability to both confine and absorb heat from a high-current arc . . . repeated exposure to operating temperatures as high as 650°F has no effect on the plates. This is only one of the reasons OHIO BRASS COMPANY selected MYCALEX 410 glass-bonded mica plates for its THOREX lightning arresters.

Rugged MYCALEX 410 plates comprise the arrester's vital element in which they function to stretch, cool and extinguish the power arc. Only 2″ in diameter and 1.43″ high, the element provides a substantial total arcing path of 33″.

Of equal importance, the mechanical strength of these gap plates permits an automatic riveting operation which secures the gap electrodes.

Formulated to withstand high voltage and high frequencies, MYCALEX 410 is but one of a family of versatile electrical and electronic quality insulating materials produced by the MYCALEX CORPORATION OF AMERICA . . .

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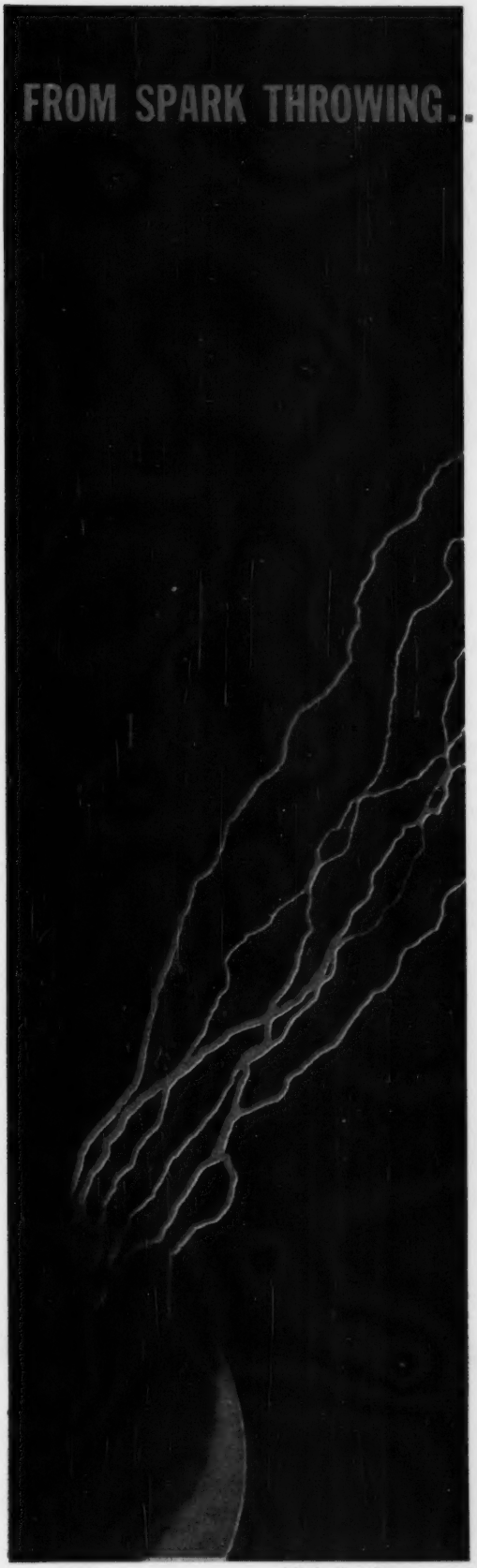

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HOW SOUTHERN STATES' BV-33-F CUTOUT CLEARS RESTRICTED OR HIGH FAULTS WITH EQUAL DEPENDABILITY

The complexities of today's distribution systems present a real challenge to the designers of cutouts. Industry requirements call for interrupting capacities up to three times higher than a few years ago. And yet the cutout must clear restricted faults with equal ease and sureness.

Large bore tubes, vented freely at both ends, will clear extremely high faults easily. Small bore tubes, vented at one end, will clear low faults easily. The big problem is to do both.

The Southern States BV-33-F Heavy Duty Cutout clears the complete range of fault currents with equal dependability—without damage to the cutout.

What About Single-Venting?

In single vented cutouts, the rocket effect of the tube, as gases are ejected, must be considered. Some type of shock absorber to cushion the fuse holder, as it tends to thrust upward, must be provided. But so far no practical recoil mechanism has been devised that can fully absorb the violent recoil action. Thus a substantial amount of shock is transmitted to the mounting, insulator, bracket, and cross arm.

As interrupting capacities on single-vented cutouts are increased, bore diameters become critical. If it is large enough to handle high faults, it may provide only borderline protection on restricted faults. Resorting to some extraneous means, such as special types of fuse links, is a dangerous concession to security—as there is no assurance of proper fusing in the field.

What About Controlled Venting?

Providing a small vent hole in the top hardware to permit a limited amount of gas to escape is not the solution either. This practice was dropped by Southern States long ago, when it was found that the hole became enlarged after each operation, endangering proper clearance of low faults.

Here's the Answer

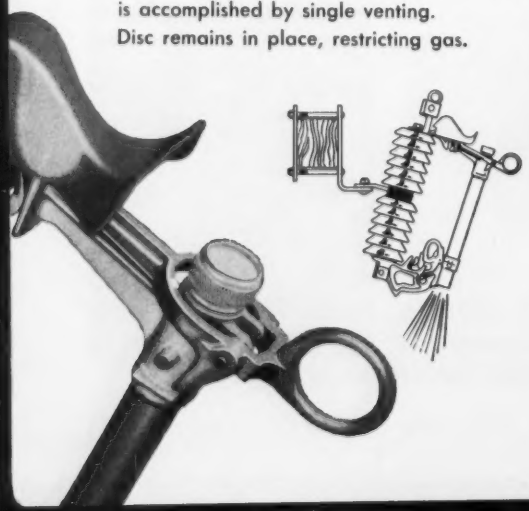
The BV-33-F offers all of the advantages and none of the disadvantages of single-venting or controlled-venting. This is accomplished with an economical expendable cap which confines gases on restricted faults, but allows them to double vent on high faults. Forces inside the tube are equal and opposite. Stress on the mounting is virtually eliminated. The cutout can operate time and time again without loss of efficiency. There is no built-in battering ram—no intricate mechanism, or springs to worry about. And any standard EEI-NEMA fuse link will provide positive operation every time.

Utilities throughout the nation are finding the BV-33-F a practical, workable solution to cutout problems.

Get complete information from your Southern States representative, or write for Bulletin 580C.

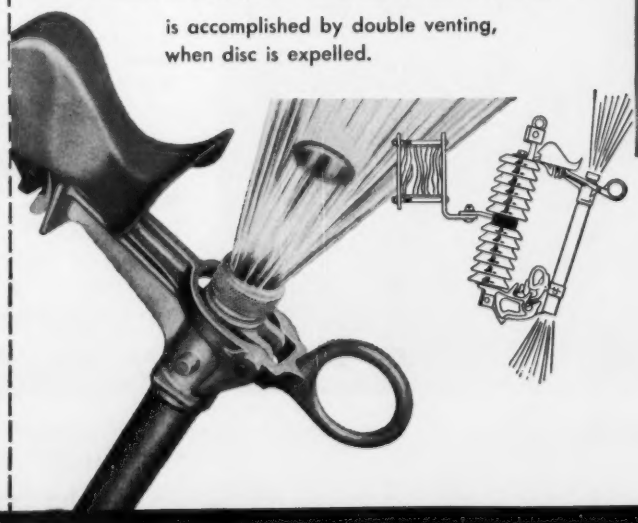
LOW FAULT CLEARANCE

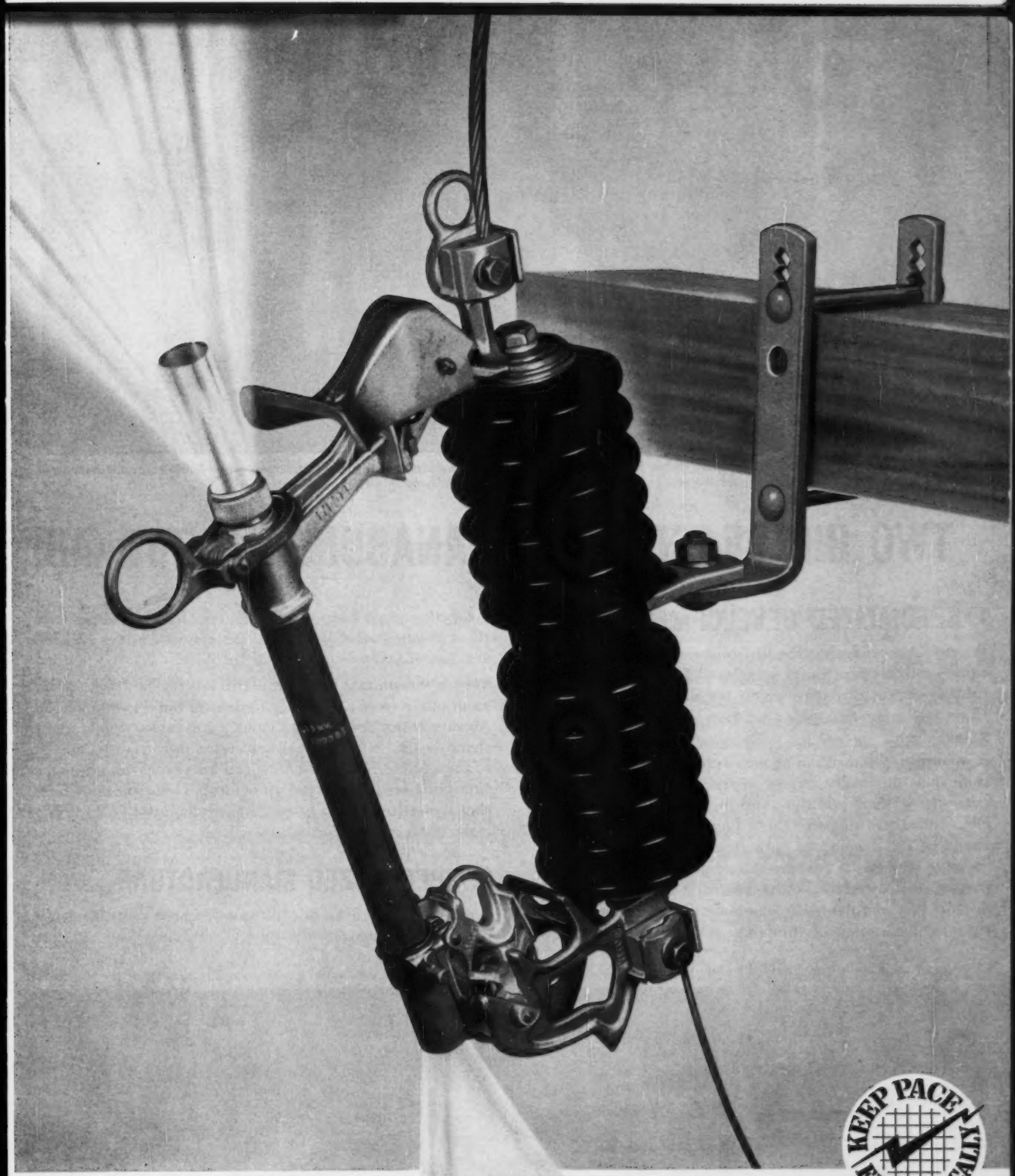
is accomplished by single venting.
Disc remains in place, restricting gas.



HIGH FAULT CLEARANCE

is accomplished by double venting,
when disc is expelled.





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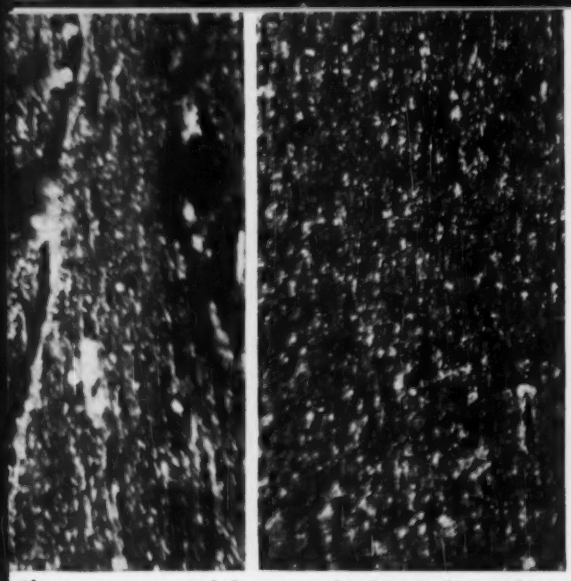
HAMPTON, GEORGIA

IN CANADA Dominion Cutout Co., Ltd., Toronto



Above you see magnified sections of ordinary cable insulation (left) and Anaconda Butyl (AB) Cable insulation (right).

These screens, used in the extrusion head to entrap possible contaminants, are so fine they actually hold water.

TWO BIG REASONS WHY ANACONDA BUTYL (AB)

1. SPECIALIZED DEVELOPMENT

Because Anaconda was the first to develop butyl-insulated cable—and because butyl handles differently from other rubbers—many problems came up during development. Here are some examples—and how Anaconda engineers solved them.

A mixing problem: Like all raw rubbers, butyl in its raw state is a practically useless material. So it's mixed with specially selected additives and ingredients. Because it is very difficult to disperse these ingredients in butyl, Anaconda had to develop an entirely new mixing process and separate facilities to avoid contamination. Look at the comparison photos and see how successful it is.

A shielding problem: To eliminate laborious and time-consuming cleaning of insulation surfaces, Anaconda developed a semiconducting tape* which firmly adheres to the insulation—and yet is easy to remove during splicing and terminating.

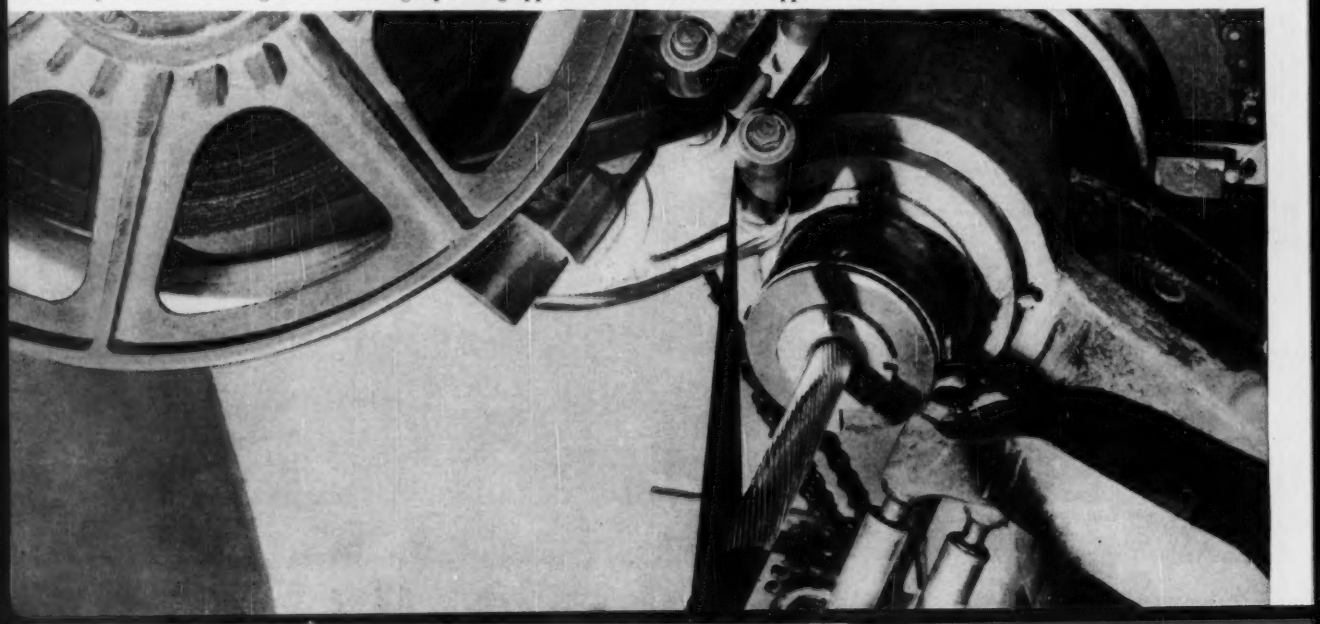
Even a vulcanizing problem: Ordinary vulcanizing equipment might have a tendency to deform butyl insulation. So Anaconda developed huge vulcanizing tanks which admit steam faster, vulcanize quicker and eliminate distortion.

These few examples show you the types of problems Anaconda engineers were up against. Their solutions help show you why you can be sure Anaconda Butyl (AB) Cable is the finest cable you can buy.

2. SPECIALIZED MANUFACTURE

Anaconda's new Marion Mill was designed to handle only one product—Anaconda Butyl (AB) Cable.

Close-up of semiconducting strand-shielding tape being applied to 500-Mcm tinned copper conductor.



An Anaconda development—semiconducting tape—adheres firmly to insulation, yet removes easily, facilitating splicing and terminating.

MEANS RELIABLE HIGH-VOLTAGE CABLE

The men behind this highly specialized equipment have but one job . . . to study and improve the design and manufacture of rubber-insulated high-voltage cable. Here are a few of the many places where they built precision right into the production line.

Insulation purity: For extra protection against contamination, the unvulcanized Anaconda Butyl is passed through a series of screens, one of which is so fine it will hold water.

Strand-shield taping: For better equalization of internal electrical stress, Anaconda applies a special fine-mesh semiconducting tape under the insulation of all stranded high-voltage cables.

Vulcanizing in lead: Conventional lead presses must stop periodically for refilling—severely heating up and often damaging the cable section in the die block, so Anaconda extrudes lead continuously. In the next step, exceptionally large drums are used for vulcanizing in lead to eliminate distortion of jackets and insulation.

These few examples help show you that the manufacture of Anaconda Butyl (AB) is highly specialized, highly precise—and why Anaconda offers you the big advantage of consistent high quality.

*Pat. applied for 60237

ASK THE MAN FROM

ANACONDA®

ABOUT BUTYL (AB) HIGH-VOLTAGE CABLE

Huge reel entering large vulcanizing tank which vulcanizes cable quicker than conventional methods, eliminating distortion of insulation.

SQUARE D announces NORpak

—A SIMPLER, FASTER, STATIC CONTROL!

NORpak is a significant advance in the field of static switching. Like other static systems, ***NORpak*** performs the functions of machine tool relays, stepping relays, latching relays and timers —all without contacts or motion of any kind. Like other static systems, ***NORpak*** is ideal for applications where speed is important—where reliability and long life are essential—where conditions make conventional magnetic devices impractical.

But unlike other static switching systems, *NORpak* offers these important advantages

EASIEST TO APPLY

The transistor NOR unit is the basis of ***NORpak.*** All logic functions—AND, OR, NOT, MEMORY—can be accomplished with combinations of this single NOR unit.

NORpak is *not* complicated — it's easy to apply to conventional circuits. Units are color-coded for quick identification. Simple DC circuit eliminates worry about phase relationships.

EXTRA DEPENDABILITY

NOR units have been time-tested in computer use for years. They are not subject to wear, will give top performance indefinitely, and provide unfailing circuit fidelity.

SIMPLE TO USE

Optional monitor lights give visual evidence of proper performance. Simple dynamic sequence tester checks individual NOR units in operation.

UNMATCHED SPEED

NORpak provides switching at rates up to 25,000 per second—faster than any other industrial static system.

EXPERT APPLICATION HELP

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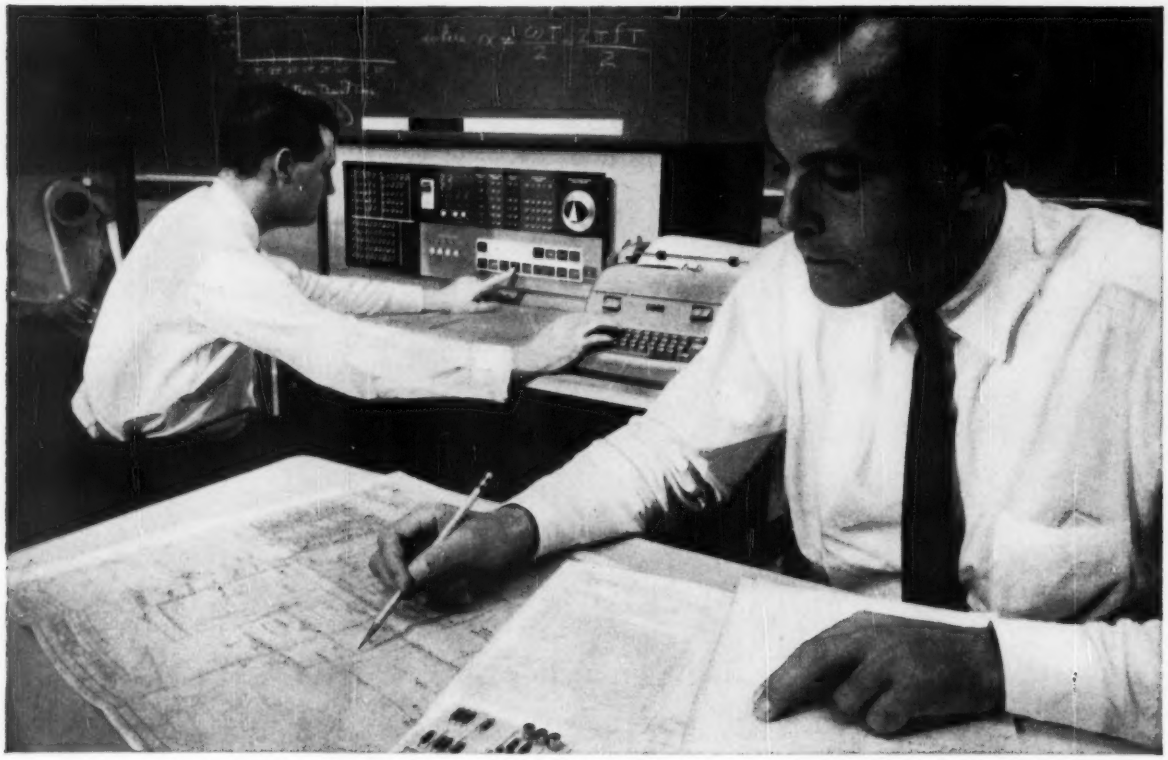

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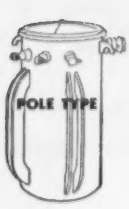

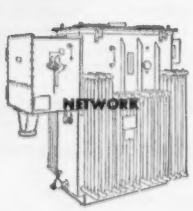

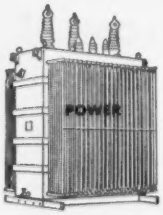

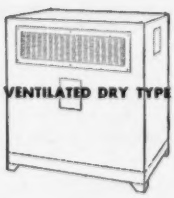

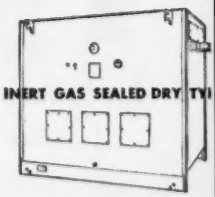

"Would You Have Student Engineers Any Other Way?"

STEPHEN FREEMAN, JR.

MEMBER AIEE

The Institute looks toward its Student Branches as the logical source of future Section members. In order to promote student interest, the AIEE must encourage Student Branch activities that can compete on their own merits for the limited free time available to electrical engineering students.

THESE DAYS, AIEE looks at the Student Branches as its largest and most logical source of future Section members. Distinguished leaders of the Institute seek effective ways to persuade more student members to become active Section members when they graduate from engineering schools and become employed.

As a faculty counselor of an AIEE Student Branch, I know that my fellow counselors and I share with other electrical engineers the same desire to see more student members of AIEE become active associate members, taking part in alert AIEE Sections. My fellow counselors and I are grateful for, if sometimes a little bewildered by, the effort put forth by Institute Committees in devising plans, better bookkeeping methods, and other mechanics for easing the process of transferring student members to associate membership.

From the practicing engineer one sometimes acquires the impression that the engineering student is already an apprentice of a kind. It is perfectly natural for the engineering industry to feel that the young engineering student in training would profit by taking more time to listen to his working senior. Respect, and in many cases awe as well, for engineering achievement the student gives freely. Respect for achievement and desire to share in it is a great part of the motivation that keeps an engineering student at his work. Time is another matter. Unlimited time is not his to give, even if he would. Nor was it for us who graduated 20 years ago, if we would but remember.

It seems to me that what we need to do most is to sit down in a quiet corner and attempt to arrive at a better picture of these young people, how they behave, what they think about, the factors which influence what they do. What I write here in this attempt to tell you my beliefs about these matters will evoke disagreement as well as many an answer, "Why, I know that!"

To those who disagree I urge that they, too, take some time to think and to set down their thoughts about student engineers before they recommend. To the rest who say with me, "Why, I know that!" I say only, "Yes, but how much do we actually consider the students' viewpoint before acting on matters that concern student members?" We profess, often with some impatience, to be at a loss to understand why students and young people of student age do not respond quickly to *our* plans for what *we* deem their benefit. As I watch Institute committees at work on this problem, I find myself keenly aware of the genuine good will toward students brought to bear by the various committee members and the leaders of the Institute.

So I would first attempt to sharpen our insight and understanding of young people by a test which most of us can make in our own homes. The next time a family gathering of differing ages collects in your living room, or at your dinner table, I propose that you deliberately stir up an argument among the younger people present. Stir it until your own desire to squelch the discussion and have peace rises high. Then, exercising more patience than I often find available, sit back and listen and observe! If you listen well, familiar phrases, gestures, turns of argument will most surely come back to you. Whence come these familiar echoes and characteristics, both those you admire and those not so admirable? For the answer, catch your wife's eye, and smile, if you can, both proudly and ruefully, too. You must surely share the acknowledgment that these young people, like the young people of homes everywhere, are indeed the children of their parents; they think, in considerable measure, just as their parents do, and act as they have observed their elders acting.

What, then is the difference? To me the difference is simply our particular packet of experience and maturity—10 to 20 years worth. They live in a faster moving world than we did at their age. Their store of knowledge—although we may sometimes feel impatient about the missing portions of it—is greater than ours was. Today's schools are better than ours were (they'd better be) and the incentives to learn are greater. More young people go further through the schools than they did 20 years ago. They are like we were at this age, but they have had opportunities to learn more and to become more able than we were. And I think they are! But they have not had our added years of experience (which we can only hope have been worth the cost) and we cannot expect them to respond as if they had. But you say again, "Why, I know that." I can only reply,

A special article recommended by the AIEE Student Branches Committee.

Stephen Freeman, Jr., is professor of electrical engineering, Purdue University, Lafayette, Ind.

The author wishes to thank R. B. Gear, vice-president, AIEE District 5, for thoughtful criticism and wise counsel.

"Surely, but do you consider that factor well when you plan activities for their benefit?" Let us be sure we do, and not expect responses that we could not have had when we were that age.

TODAY'S COLLEGE ENVIRONMENT

BEFORE we apply ourselves again to providing incentives for student engineers to become AIEE members, let us refresh our memories of the environment in which our young people find themselves and the differences between the time when we were students and now. Nowadays studies are at least as demanding as they were 20 years ago. Personally, I believe they are more demanding, because both the amount and complexity of technical knowledge in all fields has increased. All serious students—and engineering students must be serious students—must study long and late each weekday night, as well as during the day. For proof, ride about any college campus at midnight. Study lamps and heads bent over desks and books far outnumber darkened windows. Besides this "regular" work, which in large measure is as great, or greater in quantity than it was when we were there, there are far more diverse and more attractive extracurricular activities on most campuses today.

Varsity athletics are spectator sports for all but the very few undergraduate engineering students who possess both superlative phyiscal ability and a top-speed set of mental gears. But even as spectators, students find athletic contests scheduled on weekday nights in greater and greater number. Add to athletic events the truly excellent cultural entertainment which comes to any campus equipped with a sizable auditorium. Add social activities, hobby groups, intramural athletics, student honorary societies. To all of these we would add worthwhile AIEE Student Branches with activities designed to attract students and make them want to continue as full members when they graduate.

Now let us look again at AIEE and its student branches and the student members we would like to see become Section members. These young people are like we were when we were 20 years old. However, they are busier than we were; they have more studying to do, and they work at it. They have many more things labeled "worthwhile" to distract them from their 72-scholastic-hour workweeks. Far more frequently than you or I did, they must choose how best to divide their time among worthwhile things. "Which, if any, activity is worth taking 2 hours or more off from studies tonight?" They must choose critically and firmly in the light of their own best judgment. And I ask, "Would you have them any other way, in this modern high-pressure world of calculated persuasiveness?"

STUDENT BRANCH MEETINGS

IT SEEMS TO ME that we in AIEE must see this clearly and plan carefully to encourage activities that can compete on their own merits to attract student members and participants. Again I hear an echo, "Why, we know all that." And I would ask each individual to answer for himself these questions: "Am I planning and acting as if I did? Am I trying to weigh what I propose through my son's eyes?"

At the university where I have been counselor for the past 7 years, we learned through bitter experience to test each proposed speaker and topic for joint Student Branch meetings. Each group of student officers was urged to meet together and ask themselves individually these questions about each proposed program.

1. "From what I know about this program or this speaker, or the combination of program and speaker, would I take a weekday evening voluntarily to attend?"
2. "Would my roommate, or my friend who is not a Student Branch officer, also attend, voluntarily, from what I can put in an announcement or tell him?"

In the years of my counselorship, when we could persuade our Student Branch officers to adhere to this test, we have had good meetings with steadily increasing attendance. There has been strong interest in the Student Branch and in AIEE and Institute of Radio Engineers (IRE). In other years when this test was not followed consistently, general student interest did not develop.

If Student Branches find some such careful appraisal of speakers necessary in order to assure voluntary attendance at meetings, is it not still more important for those who provide the speakers and pay their expenses to select carefully the men who represent them before students? Student Branch officers are interested in providing meetings which will perform a service to students and stimulate interest in branch membership. Engineering firms who provide speakers in the name of the Institute are interested in having their firms appear in a favorable light before future engineers, as well as in promoting AIEE.

No matter how able the engineer who represents his company before a Student Branch, if he cannot hold the attention of a voluntary audience, he helps neither his company nor the Institute. If he thinks he does not need to plan carefully or to try hard to hold the interest of a group of students already surfeited with a day's lectures to which all students *must* listen, he serves neither the students nor himself.

Students, particularly engineering students about whom I know, are decent, warm-hearted, very human adults. They want to know, for instance, about AIEE, and *once* each year at the university where I teach we can count on the electrical engineering students' coming out in large numbers just to hear what AIEE and IRE are all about. More than one distinguished engineer can bear witness to this statement. Students ask only that AIEE activities be worth their time in comparison with other worthwhile things, and that programs be warmly and intelligently presented. In this day and age, "Would you have them any other way?"

Finally, would you have these young people—who are, after all, our own sons and daughters—choose to join our Institute on any other basis?

The Brownlee Hydroelectric Project

G. B. SOULE
T. R. HEIKES
MEMBER AIEE
W. B. MITCHELL
ASSOCIATE MEMBER AIEE
O. E. SCHAUFELBERGER
ASSOCIATE MEMBER AIEE

THE BROWNLEE PROJECT is the first step in the comprehensive development of the middle stretch of the Snake River between Weiser, Idaho, and the upstream end of the Hells Canyon gorge. The ultimate development will consist of three projects, developing a total head of 602 feet with an initial installed machine capacity of 822,000 kw. A Federal Power Commission license was issued August 4, 1955, for the construction of the three projects. Design drawings were approved by the Commission on November 3, 1955, and construction was started at Brownlee a week later. Within the short space of 32 months, the first unit was pumping power into the interconnected systems of the Northwest Power Pool. At the peak of the construction effort, 3,400 workers and $7 million worth of heavy construction equipment were used.

The Brownlee site is on the Snake River approximately 70 miles downstream from Weiser, Idaho. Geologically, the project area is covered with thick beddings of basaltic lava. A rock projection on the left bank provided an ideal location for the spillway, and the sound rock on the right bank was well suited for boring the diversion and penstock tunnels. Economic studies showed that a rock-fill would be the most feasible. A fill-type structure could be placed on the overburden, requiring only the excavation to bedrock of a trench for the impervious core and a trench at the downstream toe filled with large rock to prevent erosion of the river overburden.

The reservoir created by the dam is 57½ miles long, with a total impoundment of 1.470 million acre feet, a usable storage of 1 million acre feet, and a surface area of 15,000 acres.

The spillway is located in a rock projection on the left bank of the river. To make room for the structure, a cut of more than 200 feet wide and 150 deep had to be carved in solid rock.

The most spectacular excavation made was the intake channel to carry the water from the reservoir to the penstocks. The channel was blasted in solid rock on the right bank and is about 900 feet long and 210 feet wide at the normal water level, and the rock cut is 450 feet deep at the maximum section, which allows the power plant to operate with the pool drawn down 101 feet.

Each turbine is fed by a penstock about 512 feet long, installed in a tunnel through solid rock, having an inside diameter of 24 feet and made from welded firebox steel. After all welds were satisfactory, concrete was placed around the penstocks. A wheeled gate 16 by 30 feet is installed at the head of each penstock.

The Snake River in this area is relatively free of trash. However, it was recognized that protection of the turbines required some means of preventing large debris from entering the penstocks. Various schemes were studied and the one selected was a removable, semicircular steel cage-type structure over each penstock opening.

The powerhouse is located on the right bank. At the right-hand end of the structure the rock excavation is over 300 feet deep. The powerhouse is the outdoor type. A berm 35 feet wide on the cliff side of the powerhouse serves as a roadway to the erection deck at the right-hand end of the structure.

Four hydraulic turbines were furnished by the S. Morgan Smith Company. Each turbine is rated at 142,000 hp at 235-foot gross head and operates at 128.6 rpm. The turbines are reaction type and are built to operate under a maximum gross head of 277 feet. Scroll cases are *T-1* alloy steel and were field welded.

The generators are Westinghouse Electric Corporation umbrella-type, outdoor, vertical machines with direct-connected main exciters. They have a continuous rating of 100,111 kva, 90% power factor. The generators are equipped with the conventional carbon dioxide fire-extinguishing equipment. To supplement the usual thermostats, a gas analyzer is used to overcome the inherent lag of the thermostats. A 2-minute sampling is made of the air. The sample is compared for infrared absorption with a known sample of the gas. If a difference is detected, it is amplified by an electronic amplifier which triggers the extinguishing system. World's records are believed to have been made in the erection of the Brownlee generators. Less than one month after the forms were stripped from the turbine and generator barrel the machine was rolling on the line.

The transformers are General Electric Company 3-phase units, rated at 116,000 kva, 13.8 kv/230 kv. A transformer was provided for each generating unit. Because of the importance of the units to the system, it was decided to provide an adequate fire-extinguishing system. Studies indicated that a dry chemical type would be the most economical to install and maintain.

Power for operating auxiliaries can be supplied from any one of, or combination of, five sources.

Construction of the Brownlee dam made necessary the installation of extensive facilities to permit the migration of anadromous fish to and from the spawning beds in the streams above the dam site.

Digest of paper 59-921, "Design, Construction, and Operation of Brownlee Hydroelectric Development," recommended by the AIEE Power Generation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959. Published in AIEE *Power Apparatus and Systems*, Dec. 1959, pp. 1388-1405.

G. B. Soule, T. R. Heikes, W. B Mitchell, and O. E. Schaufelberger are with the Idaho Power Company, Boise, Idaho.

Solution of Phase-Interchange Faults

W. H. FERGUSON
MEMBER AIEE

A PHASE-INTERCHANGE FAULT on a power system occurs when two of the three conductors are interchanged. If the portion of the power system involved is a radial branch that has a voltage source at only one end, the consequences are reversed phase rotation in the branch beyond the point of phase interchange. Although the physical consequences may be serious, the calculation of the resulting currents and voltages are relatively simple. If the portion of the power system involved has voltage sources on both ends, as in a loop or network, the phase interchange has the effect of causing large currents to flow in the power system, and their analytical determination is more difficult and complex.

For a fixed fault location and considering both phase-interchange and 3-phase faults, it is possible that the line currents may be greater for the phase-interchange fault than for the 3-phase fault. Voltages between phases are reduced and, except for particular fault locations, some parts of the system will be subject to phase rotation reversal.

The method of symmetrical components is the most widely used and accepted tool for analyzing unbalanced circuit conditions. The connection of the regular positive- and negative-sequence networks shown in Fig. 1 has been derived to aid in the analytical solution of phase-interchange faults. These connections apply whether the phase interchange occurs in a loop or on a radial section of the power system. The method of system grounding is not material; note that the zero-sequence network is not energized.

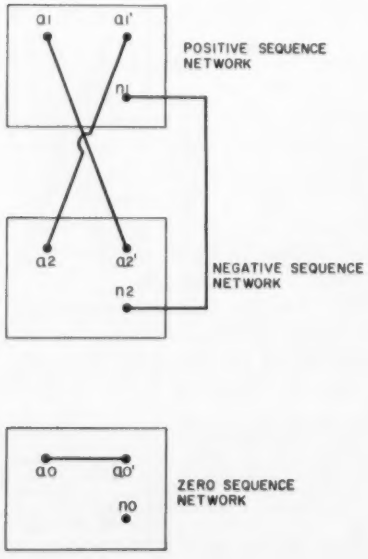

Fig. 1. Symmetrical component connections for phase-interchange faults.

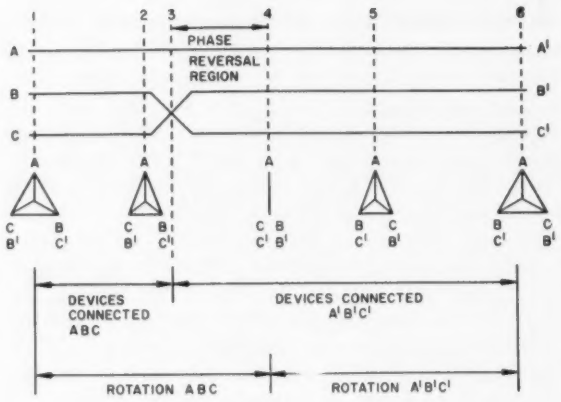

Fig. 2. Illustration of phase rotation reversal due to a phase-interchange fault.

The notation in Fig. 1 is one commonly used whenever series unbalances are treated by the method of symmetrical components. Each sequence network is opened at a point corresponding to the physical fault point and two terminals are brought out. The unprimed terminals are on one side of the open circuit, the primed numbers on the other. Each network neutral is also identified and supplied with a terminal for external connection. The connections shown in Fig. 1 determine the currents which flow in both the positive- and negative-sequence networks. These currents can be combined, using the regular procedures of symmetrical components, to yield the phase currents of the real power system.

Fig. 2 shows in a schematic way how the problem of phase rotation reversal can occur in a loop system. Points 1 and 6 are both on the supply bus and points 2 through 5 are on the looped circuit between them. The phase interchange occurs at point 3. The impedance center of the loop is at point 4, and the *B-C* voltage collapses to zero at that point. In the region between points 3 and 4 the load devices are subject to a voltage phase rotation opposite to that for which they are connected. The phase-reversal region becomes larger as the interchange fault point approaches the supply bus. The phase-reversal region disappears completely only for the special case of phase interchange at the impedance center of the line, i.e., points 3 and 4 coinciding.

Digest of paper 59-564, "Symmetrical Component Network Connections for the Solution of Phase-Interchange Faults," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Empire District Meeting, Syracuse, N. Y., Apr. 29–May 1, 1959. Published in AIEE *Power Apparatus and Systems*, Oct. 1959, pp. 948–50.

W. H. Ferguson is with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

Shielding 13.8-Kv Distribution Circuits

M. L. HURSTELL
MEMBER AIEE

M. G. WEST
MEMBER AIEE

THE DISTRIBUTION SYSTEM for all new residential and commerical areas developed in New Orleans since 1943 has been constructed to operate at 13.8 kv with conversion of the old 4-kv system to 13.8 kv beginning in 1945. The use of 13.8-kv circuits raised the distribution lines above the surrounding shielding, thereby increasing exposure to lightning. As more and more of the 4-kv circuits were converted and the 13.8-kv system expanded, this exposure continued to increase, resulting in an increased number of circuit outages during thunderstorms. Since New Orleans is in an area that can expect 75 thunderstorm days per year, some steps had to be taken to reduce the increased exposure.

Previous experience of the Nopsi shielded 115-kv transmission system proved that ground wires were effective in obtaining good lightning protection. Based on the performance of the 115-kv system, it was decided that a 13.8-kv circuit would be shielded in order to gain experience with shielding on lower voltage lines.

In 1950 one older 2-circuit pole line whose route was in an area particularly vulnerable to lightning was shielded. A 3/8-inch copper-clad separate ground wire was mounted 4 feet above the plane of the conductors, thereby forming a shielding angle of 45°. The performance of the shielded circuit was excellent as compared to unshielded circuits on adjacent streets.

The impulse level of all 13.8-kv circuits (including wood crossarm braces) is 175 kv and 145 kv (positive) for 3-phase mains and lateral taps respectively. Lightning arresters are installed on all distribution transformers, with an occasional application on cable terminations, and along the line when the express portion of a distribution circuit is extremely long. Earth resistivity is approximately 10 meter ohms and ground rod tests (one 5/8-inch by 8-foot copper-clad rod isolated from the system neutral) average 5 ohms with a maximum of 10 ohms.

In 1951, additional shielding was accomplished by relocating the system neutral from the secondary plane to the shield position, thus eliminating the need for a separate ground wire. The system neutral was continuous throughout the Nopsi service area and grounded at every third pole. To reduce the ground path resistance, the system neutral for shield wire application is grounded at every pole.

A definite program of shielding older 13.8-kv lines was initiated in 1953 as a supplement to that shielding accomplished concurrently with new 13.8-kv construction and was justified by the satisfactory experience obtained with the trial shielding. A total of 208 miles of old 13.8-kv circuits have been shielded at an average cost of $1,600 per mile. For new construction, the additional shielding cost involved is primarily the incremental cost of the taller pole.

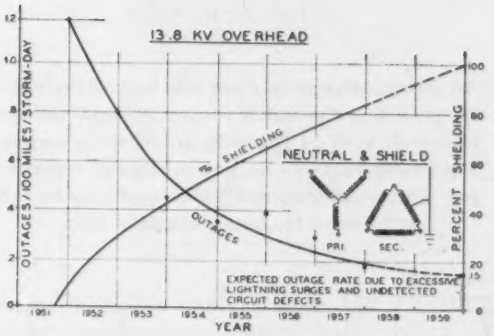

Fig. 1. Effect of shielding on outage rate due to lightning per 100 circuit miles per storm-day.

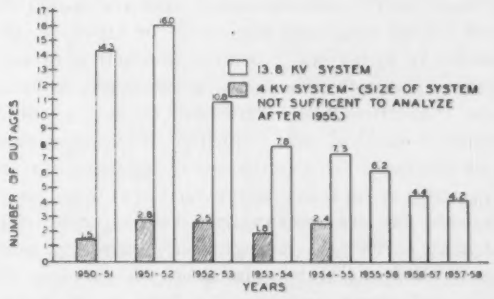

Fig. 2. Average number of outages for each circuit per year.

An analysis of system performance data indicated a definite relationship between outages during lightning conditions and the percentage shielding from 1951 to 1958. This is illustrated in Fig. 1 which shows an outage expectance of 1.2 outages per 100 miles of line per thunderstorm day with no shielding and 0.18 in 1958 with 87% of the system shielded. A 5-year comparison of 100% shielded circuits and circuits with a small percentage of shielding indicated approximately 1 to 1.2 for relatively unshielded lines and 0.15 for shielded lines.

The effect of shielding on continuity of service to the customer is illustrated in Fig. 2. It is evident from Fig. 2 that an average 13.8-kv customer had a reduction of 76% in number of momentary outages and 52% in prolonged outages between 1950 and 1958. The total customer outage time was reduced 66% by shielding.

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The Teinograph

A New High-Voltage Surge Recorder

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An inexpensive instrument has been developed for recording the wave shapes of high-voltage transients such as lightning or switching surges. The device requires no power supply, cathode-ray tube, or photographic film, and may be left unattended for long periods of time.

THERE ARE many occasions during investigations of high-voltage or high-current phenomena when it is desirable to make wave shape and amplitude records of rapid surges whose times of occurrence cannot be predicted in advance. Typical examples include lightning surges to transmission lines and surges developed during switching operations or faults on power systems. In such cases it is often impractical or too expensive to install cathode-ray oscillographs to measure these transients. The surges may be very random in nature or location, thus requiring an excessive number of oscillographs. Also, in the case of lightning, the surges may occur at localities where no low-voltage power is available for the oscillograph. Oscillographs require frequent servicing, photographic recording, moving film mechanisms, and special electronic circuitry. Thus, while it is recognized that oscillographs provide the most accurate way of recording high-voltage transient wave shapes, a need also exists for a simpler and cheaper passive device that requires no power for its operation. The earliest such devices for surge measurements were the klydonograph,[1] which was essentially a simple Lichtenberg figure discharge recorder using photographic film, and the magnetic link.[2] The former, when relying on only one Lichtenberg figure, had an accuracy of about 25% and could give only a very crude indication of voltage wave shape. The latter gave no wave shape indication at all, recording only the maximum magnetic field that had occurred in the vicinity of the link. A great amount of data has been obtained from these two instruments or modifications of them, and they have produced most of the present information on the magnitudes of lightning surges on transmission systems. However, in recent years, the occurrence of very high lightning flashover rates on transmission lines[3] has emphasized the need for better instrumentation for the determination of stroke-current wave shape.

After an intensive investigation, a new instrument was developed to meet this need. This device was named the teinograph, from the Greek word *teinein*, "to stretch out," and *graphos*, "a writing." The name is descriptive of the measuring method employed in the instrument, whereby an incoming high-voltage surge is stretched out in space or time and "written down" as a sequence of Lichtenberg figure discharges. The envelope of these discharges describes the surge wave shape, and depending on the kind of dielectric material on which the discharges are created, the record can be made either permanent or temporary. Laboratory tests on the instrument show that it has considerable promise, and field tests are now in progress to gain further experience.

PRINCIPLE OF OPERATION

SEVERAL CIRCUIT VARIATIONS of the teinograph are possible. These variations fall into either of two distinct classes, called the "space-sequential" and "time-sequential" types. The time-sequential type, somewhat simpler in operation, makes a sequence of Lichtenberg figure records of the voltage magnitude of a surge at successive intervals of time, and its mode of operation is described in Fig. 1. In Fig. 1 (A), a changing voltage V is impressed between conductor AA' and ground B. Connected to AA' is a group of point-to-plane electrodes with a dielectric inserted between the point P and the plane, and with the point tied to AA' through resistor R. As long as switches S are open, no voltage can appear across the electrode assemblies. If, however, at time t_1 switch S_1 is closed, a voltage equal to the sum of the constant voltage V_0 (of opposite polarity to V) and the changing voltage V at that instant is produced between point P_1 and its plate. Lichtenberg discharges will spread across the dielectric at P_1, and the diameter of the discharge pattern will be proportional to the sum of the two voltages at that instant. If switch S_1 is then opened immediately, the pattern diameter cannot change, and knowing the magnitude of the "trigger voltage" V_0, the value of V at time t_1 can be readily determined from pattern measurements. In some cases V_0 can be made zero, but since Lichtenberg figures generally must have a voltage of at least 2 kv in order to form a "bias," voltage of this value is helpful provided the polarity of the surge to be measured is known

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in advance. If switches S_2, S_3, etc., are then closed momentarily at times t_2, t_3, etc., respectively, records of the voltage V at these discrete times can also be recorded. In this manner, a record of the wave shape of V can be obtained as a sequence of Lichtenberg figures.

For the time-sequential teinograph, the operation of switch S may be either mechanical or electrical, depending on the speed desired. Slowly changing voltages having periods of several thousand microseconds (such as some switching surges) may require only mechanical switching. However, mechanical operation of the switches of Fig. 1 (A) is not practical when microsecond surges are to be measured, and other means must be used. One such approach is given in Fig. 1 (B). The incoming surge is delayed a microsecond or so before being applied to conductor AA', just as the signal to the vertical plates of an oscillograph is often delayed in order to initiate the sweep. The voltage wave is also fed to a pulse generator (a step-up pulse transformer and spark-gap arrangement) whose output is a high-voltage surge having a polarity opposite to that of the surge to be measured and a duration of a fraction of a microsecond. This generated pulse V_0 travels down a trigger delay line toward the line termination Z_0, and at successive intervals of time is applied to points P_1, P_2 . . . P_n through capacitor C. Prior to and immediately following the appearance of this pulse at any electrode P, the voltage between P and its plate attached to AA' will be too low for Lichtenberg figures to form, provided that the ratio of R to Z_0 is properly set. Thus, Lichtenberg figures will only form at the instant the generated pulse V_0 arrives at the point electrode to pull this electrode down in potential, and the figure diameter will be proportional to the sum of the voltage V_0 (of opposite polarity to V) and the signal voltage V at that time. This is exactly the same result as for Fig. 1 (A) where mechanical switching was employed, but at a much higher speed.

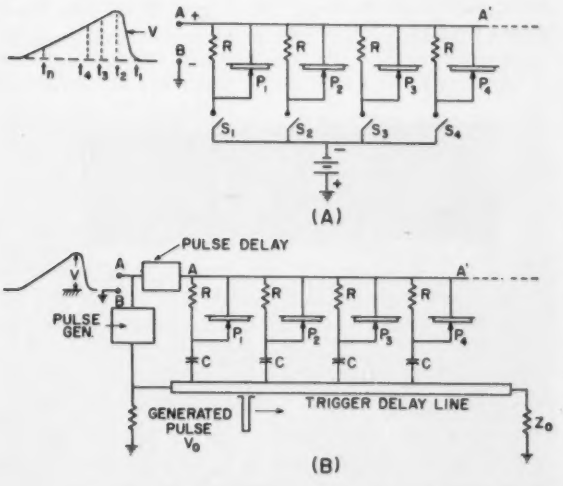

Fig. 1. The time-sequential teinograph.
(A) Basic principle
(B) Working circuit for fast surges

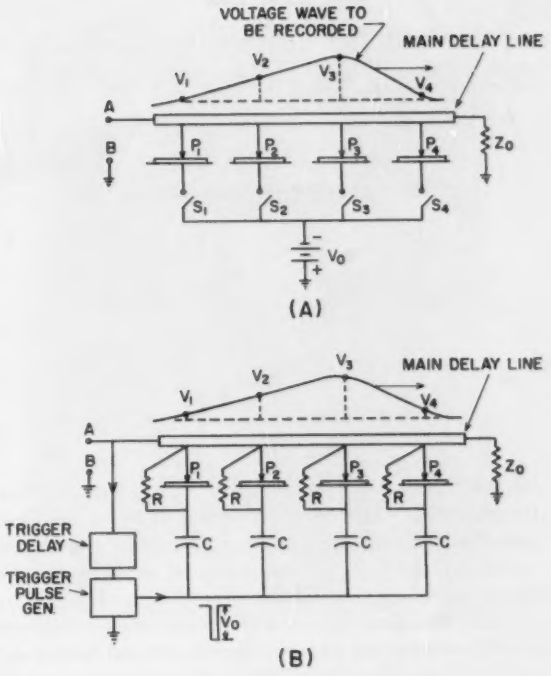

Fig. 2. The space-sequential teinograph.
(A) Basic principle
(B) Working circuit for fast surges

In practice, the circuit of the time-sequential teinograph of Fig. 1 (B) is difficult to construct. The trigger delay line must often be several microseconds long, and must carry high-voltage pulses of several kilovolts and of only fractional microsecond duration. Since this measuring technique is essentially a voltage sampling scheme, the duration of the trigger pulse must be less than that required for any appreciable changes in the sampled voltage to occur. In addition, the trigger voltage V_0 must be generated as soon as possible after arrival of the surge to be measured, and the signal V must be delayed by a pulse delay circuit until this triggering can occur. Because of the extreme requirements of the trigger delay line characteristics, a space-sequential teinograph has also been developed by a rearrangement of the circuit of Fig. 1 (B), and the remainder of this article will be devoted to the operation and experimental results of this device.

A space-sequential teinograph differs from the time-sequential type in that it spatially distributes a wave to be measured along a delay line and then, at some suitable time, samples the voltage to ground at every point along the line simultaneously. The rearrangement of Fig. 1 (A) required to accomplish this end is given in Fig. 2 (A). The incoming voltage wave V is applied to a delay line, hereafter called the main delay line, which is terminated in its characteristic impedance Z_0.

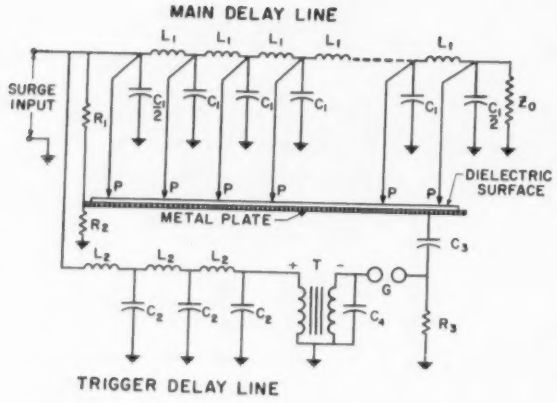

Fig. 3. Circuit diagram of space-sequential teinograph.

After a suitable interval of time, V will have traveled along the line to the position shown in Fig. 2 (A). Connected to this line are the same Lichtenberg figure recorders as in Fig. 1 (A) and the same switches. No discharge records will be obtained as long as switches S_1, S_2, etc., are open. If, when the wave has reached the position shown, all the switches are closed simultaneously for a fraction of a microsecond and then reopened, the Lichtenberg discharge pattern formed around P_1 will be proportional to $V_1 + V_0$, that at P_2 will be proportional to $V_2 + V_0$, etc. If enough recorders are used, a complete record of the wave shape at the instant the switches were closed will be obtained.

As in Fig. 1 (A), mechanical switching cannot be used for fast surges, and some electrical means must be found to accomplish the same end. A working circuit using exactly the same parts as in Fig. 1 (B) is shown in Fig. 2 (B). The trigger delay line of Fig. 1 (B) has now become the main delay line of Fig. 2 (B), and the pulse delay, instead of delaying the signal to be measured, delays the initiation of the trigger pulse until the voltage V to be measured has penetrated to a point almost at the end of the main delay line. At that time, pulse V_0 is formed. This pulse initiates the same type of Lichtenberg figures described for the configuration in Fig. 2 (A), and the wave shape is recorded. Such a circuit has an advantage over Fig. 1 (B) in that the main delay line need only have a frequency response sufficient to pass the surge to be measured, whereas Fig. 1 (B) requires a delay line having the same electrical length but an upper frequency response almost 10 times greater in order to pass the very rapid trigger pulse.

In the design of almost any instrument, certain compromises can be made which will reduce cost and facilitate construction at some sacrifice of other characteristics. In some of the models of the space-sequential teinograph, these compromises have taken the direction of not dividing the plates of the Lichtenberg figure recorders into separate parts, and having the equivalent of only one resistor R and capacitor C. The resulting circuit is shown in Fig. 3 for a 5-microsecond device used to measure the wave shape of the fronts of lightning current surges. The circuit is fundamentally the same as Fig. 2 (B) except for R and C. All the Lichtenberg recorder plates have now been tied together to become one plate, and the multiplicity of capacitors C has become one capacitor C_3. Similarly, all the resistors R have become one resistor R_1, and this resistor is connected to the input end of the delay line instead of to each point electrode. The wave penetrates along the main delay line as before. As it propagates, it develops some voltage between each of the points P and the metal trigger plate, since the latter is held at a potential part way between line and ground by resistors R_1 and R_2.

Some discharge figures may appear around the points P before and after triggering, but for lightning wave fronts analysis has shown that, provided R_2 is considerably larger than R_1, these discharges are either small or of opposite polarity from those appearing during the triggering process. Hence, they do not usually interfere with the record. The same incoming surge to be measured also passes through the trigger delay line and, after a time interval, arrives at the pulse transformer T.

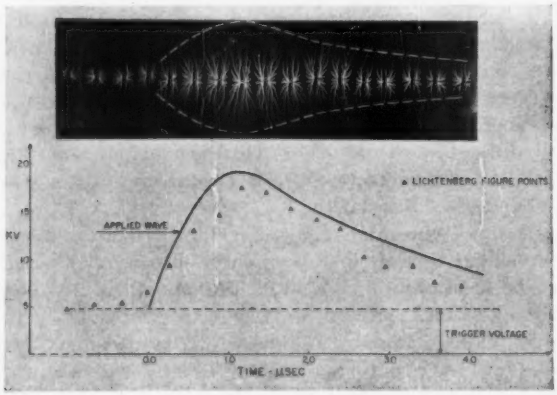

Fig. 4. Teinographic record of impulse wave on photographic film. (Time to crest: 1 microsecond.)

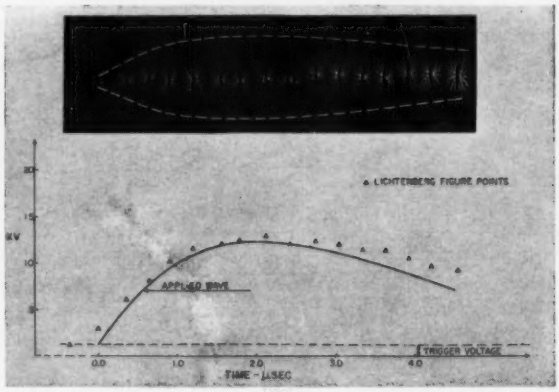

Fig. 5. Teinographic record of impulse wave on photographic film. (Time to crest: 1.6 microseconds.)

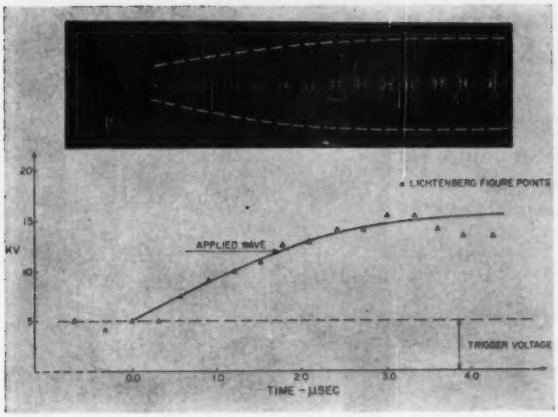

Fig. 6. Teinographic record of impulse wave on photographic film. (Time to crest: 4 microseconds.)

As soon as this wave arrives, it is inverted in polarity and greatly amplified by the transformer turns ratio. Capacitor C_4 then charges rapidly, and at about the time that the surge to be measured has almost reached the line termination Z_0, the voltage across C_4 reaches a value sufficient to spark over gap G. Capacitor C_4 then discharges into low resistance R_3. The voltage across R_3 immediately goes to a value V_0 of about 15 kv and of opposite polarity to the measured wave, but because of the short C_4R_3 time constant, falls off rapidly in a fraction of a microsecond to a low value. This is the triggering pulse previously described. This pulse pulls the triggering plate down in potential through C_3, and the discharge around each point P at that instant becomes proportional to the sum of the trigger voltage V_0 and the potential on the main delay line at that point. Figs. 4, 5, and 6 show actual Lichtenberg figure records for various input wave shapes into a teinograph of this type, and a comparison with the same waves recorded by an oscillograph. In general, the agreement is satisfactory and most of the departures from the true value can be attributed to inhomogeneities in the nature of the surface of the material on which the Lichtenberg figures were formed.

A space-sequential teinograph is shown in Fig. 7. The housing is normally covered with aluminum foil for shielding, but the foil has been removed here for display purposes. The input to the recorder is on the left end, and the high-voltage coils making up the main delay line can be plainly seen. The teinograph is essentially a single-surge recorder, and each device has a special gap mechanism in its input end which, when the first surge appears, explodes a small explosive gap[4] that shorts out the recorder input after a millisecond or so. This prevents subsequent surges from obliterating the record made by the first surge. The same gap mechanism is also arranged so that once the door of the teinograph housing is opened, it cannot be closed unless an unexploded gap is in place. This reminds the operator to insert such a gap in the circuit before a measurement is made.

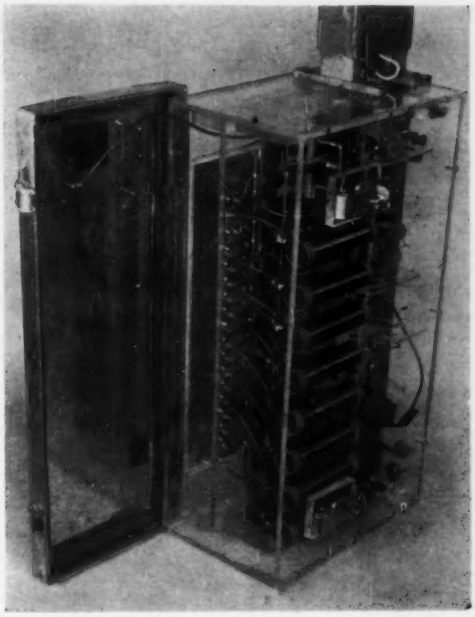

Fig. 7. An experimental model of the teinograph.

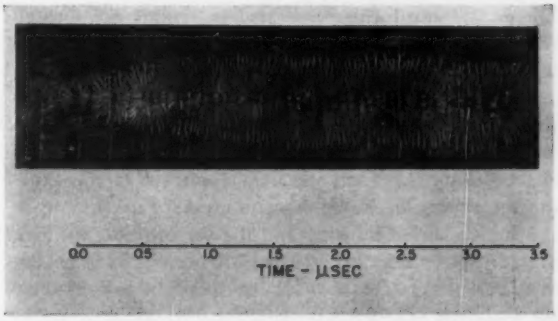

Fig. 8. Powder figure of a 1.0x40-microsecond impulse wave as recorded on Lucite plate with space-sequential teinograph.

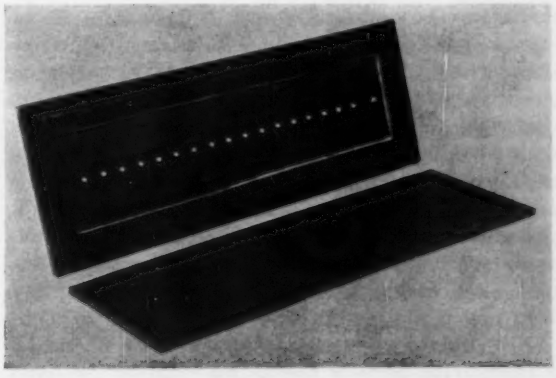

Fig. 9. Teinograph film packet for use when photographic film records are desirable.

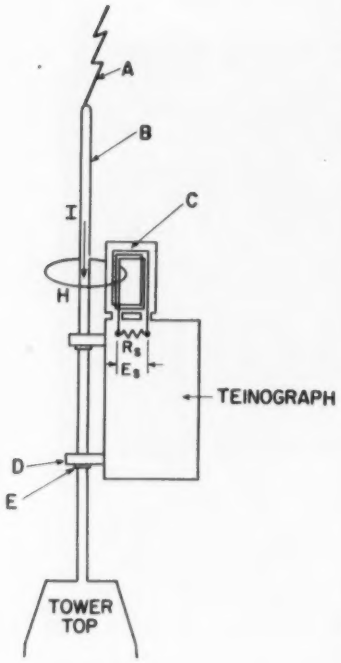

Fig. 10 (left). Teinograph operation on a tower lightning rod.
A. Lightning stroke
B. Lightning rod
C. Pickup coil in weatherproof housing
D. Insulated bracket
E. Supporting ring

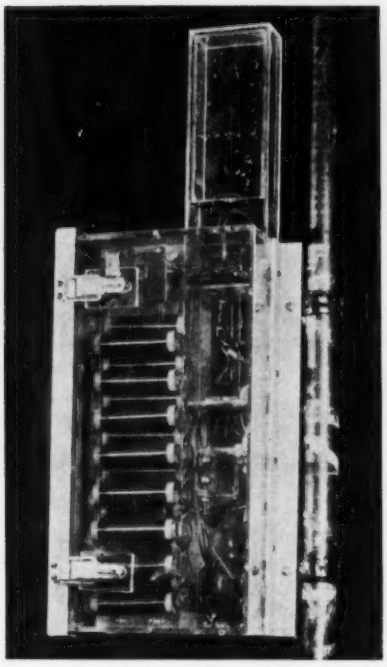

Fig. 11 (right). Teinograph installed on lightning rod for lightning current measurements.

In Fig. 7, small phosphor bronze fingers are connected to each coil and serve as the points labeled P in Fig. 3. The pulse transformer and trigger circuit are located behind the main delay line. The recording material can be either of two types. For some measurements, only a thin Lucite plate is inserted between the metal trigger plate and the points P. The discharges from the points spread out over the surface and deposit a pattern of surface charge at each streamer location. If the plate and the air inside the teinograph are kept dry by means of a tightly sealed housing and the use of desiccant, this charge pattern may be retained for periods as long as a week or more, and may be "developed" by a light dusting with fine talc. This method has the advantage that it is insensitive to light and needs no chemical processing. Fig. 8 shows a record obtained with the powder method. Experiments with powder figures on other types of dielectric plates are being made.

A series of tests comparing the recording abilities of the Lucite plate with photographic film so far indicate that the recording sensitivity of the latter is more constant. The reason for this is not yet known. To take advantage of this consistency and to permit records which will not fade away, a photographic film packet has been devised that is inserted in the same location as the Lucite plate. Electrodes imbedded within the packet and touching the film inside it make contact with the phosphor bronze fingers during insertion into the teinograph. A photograph of a packet is given in Fig. 9. This packet can be inserted in the teinograph during daylight hours, and retains its record for a year or more. Figs. 4, 5, and 6 were made with photographic film.

One of the primary reasons for devising the teinograph was to make lightning surge-current measurements on transmission line tower tops. However, any teinograph using a Lichtenberg figure recording method must have an input of 5 kv or more in order to form reasonable-sized figures. To build lightning shunts having this magnitude of output voltage and taking the full energy of a long-duration stroke would be prohibitively expensive if a large number of recorders were to be used. Therefore, some transducer other than a shunt was necessary. The problem was solved by the development of a current-pickup coil connected to the input end of the teinograph as sketched in Fig. 10 and photographed in Fig. 11. Fig. 10 shows a teinograph and pickup coil attached to a tower lightning rod. As the stroke current travels down the rod, it creates a magnetic field H proportional to the current. This magnetic field links the pickup coil, and if the output load R_s across the coil were high, would produce an output voltage proportional to the time derivative of the current. However, if R_s is kept low and enough turns are used on the coil, the coil inductance and resistance R_s form an integrating circuit so that the output voltage E_s is proportional to the current amplitude instead of the current derivative. It was found by transient tests that a single layer-wound coil 8 inches long by 3½ inches wide could be built which had an output of 20 kv for a rod surge current of 100 kiloamperes if it were loaded down with a terminating resistance R_s of 135 ohms. Thus, the coil and termination acted as a 0.2-ohm shunt, and had a transient response completely satisfactory for waves cresting in 1 microsecond or more. For waves with front times of 0.6 microsecond, some distortion of the front of the output voltage E_s was noted. This pickup coil output was not appreciably influenced by the input impedance of the teinograph

when the two were connected together, since the latter has an impedance of about 1,300 ohms (the characteristic impedance of the main delay line in parallel with the trigger circuit input impedance).

COST AND PHYSICAL CHARACTERISTICS

LIMITED EXPERIENCE indicates that, for lots of 20 or more teinographs, manufacturing costs will be from one half to one tenth that of equivalent oscillographs, depending on the desired elaborateness of the device, the writing time, and the particular application. Laboratory models have weighed about 22 pounds, but no effort was made to keep the weight to a minimum. The physical size of 18½ by 10 by 6½ inches was determined largely from the size of the main delay line and the need of sufficient insulation clearances.

FUTURE TESTS

FURTHER LABORATORY TESTS are being made on improved teinograph designs. Twenty recorders, complete with current pickup coils, have been built and are being installed on approximately 5 miles of 345-kv transmission line, one recorder on each tower. From the experience gained on these first models, it is hoped that the instrumentation can be advanced to the point where a wealth of needed information on surge magnitudes and wave shapes can be obtained in the near future.

REFERENCES

1. The Klydonograph, J. F. Peters. *Electrical World*, New York, N.Y., Apr. 19, 1924, pp. 769-73.

2. The Surge Crest Ammeter, C. M. Foust, H. P. Kuehni. *General Electric Review*, Schenectady, N.Y., vol. 35, Dec. 1932, pp. 644-48.

3 1956 Lightning Field Investigation on the OVEC 345-Kv System, R. H. Schlomann, W. S. Price, I. B. Johnson, J. G. Anderson. AIEE *Transactions*, pt. III (*Power Apparatus and Systems*), vol. 76, 1957, pp. 1447-59.

4. The Amplitude, Time to Half-Value, and Steepness of Lightning Currents, N. Hylten-Cavallius, A. Stromberg. *ASEA Journal*, Vasteras, Sweden, vol. 29, 1956, pp. 129-34.

Electrical Engineering Research for Future Space Vehicles

KARL MARTINEZ

A presentation of the problems of future air and space flight involving: (1) functional, operational, and environmental parameters and their limits; (2) new reference for research in the combined operational functions and environment; and (3) a partial interpretation of aforementioned factors for academic and research institutions.

OF THE MANY industries in existence today, aviation, including space travel, probably offers the greatest challenge to science and engineering. Most other industries have developed for operation on land, or water. Examples of such operation are: factories, mines, land and water transportation, electric power generation and utilization.

The operational and environmental functions are considered complex and demanding. By comparison, the aviation industry requires most of the functions for the examples given in addition to expanding them and defining new ones.

Each new vehicle model has to represent an advance in functions and performance outstripping its predecessors at an accelerated rate. A few examples of functions and environment are increasing speed, higher altitudes, change in gravity, rate of change of maneuverability and longer range. Speed will increase 3 to 25 times in the next several years compared to about 2 times in the past 25 years. Operational altitudes for limited and sustained flight will be in the neighborhood of 100,000 feet. In the field of missiles some vehicles have left the earth's gravitational field on their way out into space. As manned and unmanned vehicles leave the earth's gravitational field, the function will be faced of creating, if required, a gravitational field. Along with these functions is the increasing rate of climb and

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descent, far greater than ever before, and the preservation of conditions in which life, cargo, and equipment can function.

Efforts to increase range with and without in-flight refueling are continuing. This intensifies the function of aerial and space refueling and supply stations. As speed, altitude, range, and number of vehicles increase, the methods of communication, navigation, traffic and vehicle detection and management must keep pace. Facilities for quick take-offs or launchings from ground, airborne or space stations become a more rigorous requirement. Support for many functions including maintenance and take-offs has to be provided for all conceivable conditions.

The aforementioned operational functions and environment are only a few brought about by the exploration of the atmosphere and space. The order of magnitude is much greater than that found in other industries. An increasing reliability and safety are mandatory for the vehicles to perform their assigned functions. This is to be done under conditions where the operational functions and environment operate simultaneously, creating interactions not usually found elsewhere.

THE COMBINED ENVIRONMENT

OPERATIONAL FUNCTIONS and requirements dictate the environment both natural and man-made in which the vehicle must perform and the crew must live. Speed increase within the atmosphere, for example, results in a rapid rise of the skin temperature of the vehicle (Fig. 1). This means the air is always at the temperature indicated for the corresponding speed. It is the coolest temperature to be found at the surface of the vehicle. Outside the earth's atmosphere explorations indicate that the ambient temperature is higher but the heat absorption for the mass of the vehicle keeps the temperature within limits of materials used so far. Reduction of the screening effect of the atmosphere at high altitudes intensifies solar and cosmic radiation. At 40,000 feet it is estimated that the ratio of ozone to air molecules rises to around $1/2\times10^5$ compared to $1/10^7$ at sea level, while the water-vapor content becomes extremely low, approximately 1/2,000 of that at sea level.

More powerful propulsion units produce more noise, resulting in structural vibrations over a wide band of

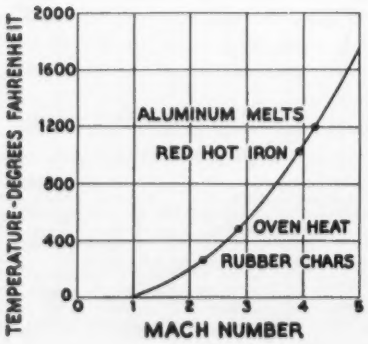

Fig. 1. Skin temperature of air vehicles at 100,000-foot altitude as function of Mach number (ratio of vehicle speed to sound velocity).

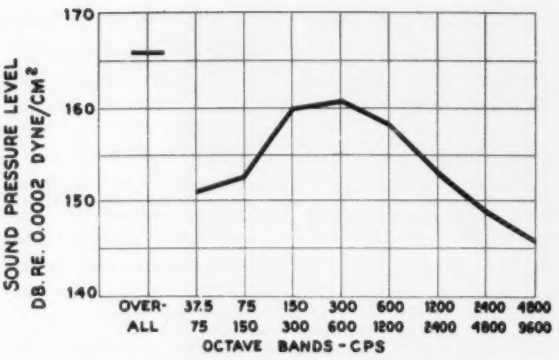

Fig. 2. Sound pressure levels and frequency distribution.

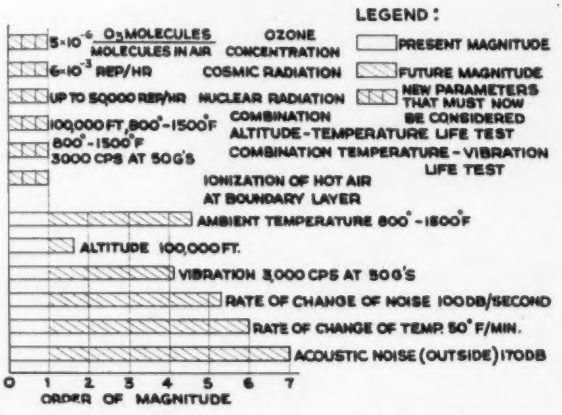

Fig. 3. Operational environment parameters in the revised reference.

frequencies (Fig. 2). Acoustical and vibration patterns and their distribution over the vehicle change from ground to in-flight cruises varying with speed and altitude. As the vehicle leaves the earth's atmosphere these changes will have still different characteristics, many yet unknown. For atmospheric vehicles, accelerations of up to 50 g's during parts of the flight may occur. For space vehicles accelerations up to 100 g's are indicated for parts of the flight.

The rate of change of environment is a serious factor. The skin temperature of the vehicle may vary by 35 F to 50 F per minute, thus producing several problems as thermal expansion and temperature coefficient of electrical resistance changes. The noise intensity may increase within a few seconds from 70 to 80 db for idling to about 160 to 170 db or higher for take-off. The water-vapor content of the atmosphere, frequently near saturation at ground level, at high altitudes drops to negligible values which force hygroscopic materials to release their moisture spontaneously.

To this partial list of combined environment will be added the detrimental effects of gases, fluids, and dust tending to deteriorate most materials and electric circuits used in the vehicles.

THE NEW REFERENCE FOR RESEARCH

SUCH OPERATIONAL FUNCTIONS and environmental parameters add up to the challenge that vehicles including passengers, cargo, and equipment are being asked to meet in a new reference world. Part of this new reference world is summarized in Fig. 3. The parameters are divided into two parts: first, those common to present-day vehicles but stepped up to higher limits, second, new parameters coming to the fore. An arbitrary order of magnitude has been chosen to illustrate the difficulty in finding compromise solutions. This new reference is dynamic in that parameters are always changing in magnitude, old ones becoming less significant and new ones being added. This depends upon the knowledge of the state of the art and its successful scientific and engineering application.

These parameters will assist in guiding research, development, and engineering in designing, building, testing, and operation of future air and space vehicles. In the very preliminary design stages it is evident that much fundamental research, development, and cooperation of materials, components, and systems will be mandatory. This indicates the need to strengthen and establish procedures to alert the academic and industrial research world better than has been done in the past. This will help reduce the ever lengthening time table for preliminary design, manufacturing, and experimental flights, including launching and putting the vehicle into production. Fig. 4 shows the increasing time table for several vehicles.

Vehicle will have to shuttle between the present and new reference, exposed to all the conditions attending this double life. This focuses the challenge of designing for transient as well as steady operation as may be required.

PARTIAL INTERPRETATION OF THE FACTORS

Improvement of Environmental Parameters

Attempts to conserve for the interior of a vehicle conditions as found near ground level prove increasingly difficult and costly. For example, cooling as a means of meeting the temperature problem must be viewed in terms of a total heat-load analysis which, in the case of Fig. 5, where cooling is required to the temperature indicated, adds up to a total of nearly 1 million Btu per hour. Where can a suitable heat sink be found for this much energy?

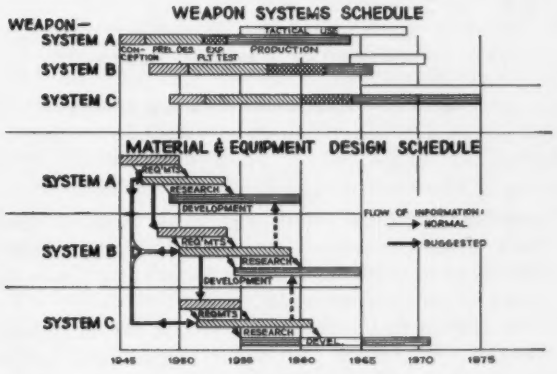

Fig. 4. Master time chart.

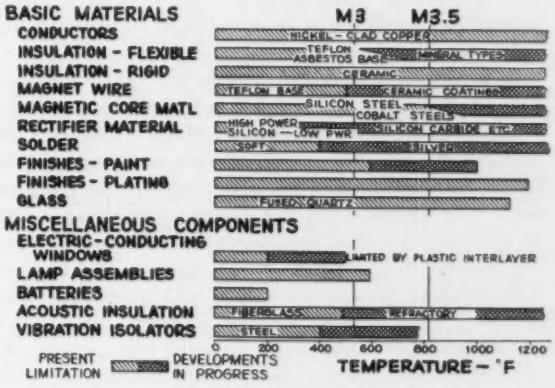

Fig. 6. Temperature limitations—electric equipment—I.

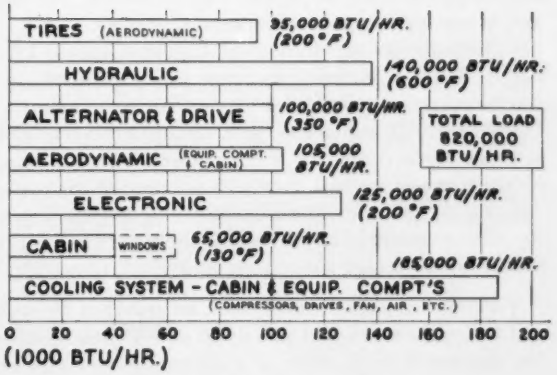

Fig. 5. Typical heat load analysis.

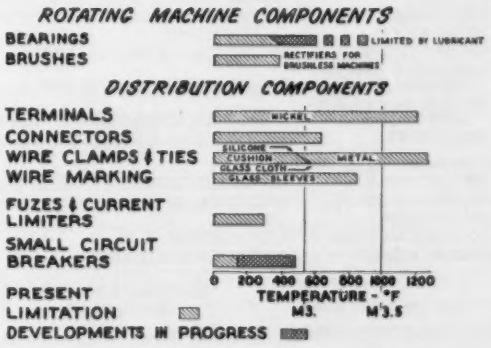

Fig. 7. Temperature limitations—electric equipment—II.

Low atmospheric pressure is overcome by pressurizing selected cabins, sections, components, and maybe even systems. This must be kept to a minimum since it is increasingly difficult and costly to do.

Other examples are available; however, these serve to illustrate that some help is obtained in this manner.

Raising the Continuous Working Environmental Threshold of Materials, Components, and Systems

After improvement of the environmental parameters, the remaining operational functions and environment are still too severe for most present materials. Some efforts are underway to upgrade materials, components, and systems. Part of these efforts are listed in Figs. 6, 7, and 8.

The next step is synthesizing new materials to predetermined operational functions and environment. This approach is in its infancy through "Molecular Science and Molecular Engineering." The empirical creation and selection of materials will be greatly reduced.

Research and Techniques Which Should Be Explored

1. High Temperature Electrical Insulation. Electrical insulation resistance decreases with increasing temperature as shown in Fig. 9. The change in resistance is from megohms to one or less ohms. This may lead to shorts with adjoining circuits or structure. High electrical insulation resistance must be maintained in order to preserve circuit integrity.

2. Lower Temperature Coefficient of Resistance. Fig. 10 shows how the temperature coefficient of resistance increases with temperature. Many circuits will be severely affected with respect to time constants, voltage drops, etc. Research in super conductivity at temperatures near absolute zero may yield information usable in reducing electrical resistance at high temperatures.

3. Higher Curie Point for Electromagnetic Devices. The decrease in saturation flux with increasing temperature, Fig. 11, means the use of larger units. This is not an acceptable solution for airborne and space equipment. In many cases the internal temperatures will even approach the Curie point of presently available materials. High-temperature magnetics research indicates alloys can be synthesized with a flatter curve before the decrease becomes noticeable.

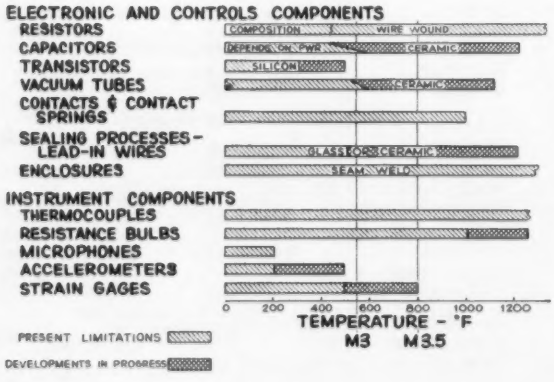

Fig. 8. Temperature limitations—electric equipment—III.

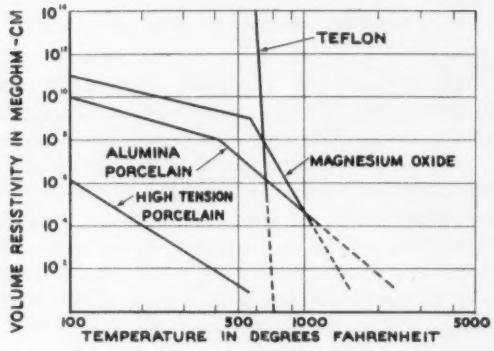

Fig. 9. Effect of temperature on insulation resistance.

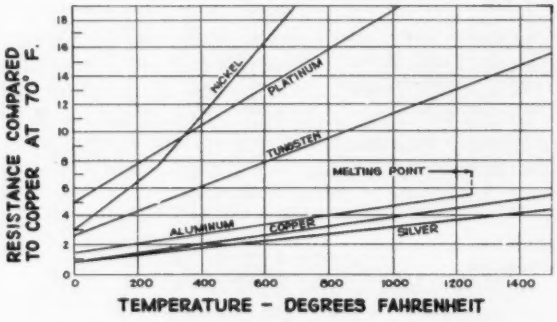

Fig. 10. Effect of temperature on electrical resistance.

4. Corona Reduction or Elimination. At the reduced atmospheric pressures and higher temperatures, corona appears, deteriorating electrical insulation and constituting a potential source of radio interference. Fig. 12 shows corona reduction by increasing spacing between wires for various voltages at 75,000 feet altitude. Suitable materials must be provided as insulation, barriers, and as potting compounds between terminals.

5. Elimination of Mechanical Circuit Control. Present methods of controlling current rely primarily on mechanical make-and-break devices such as switches, relays, solenoid contactors, and circuit breakers. This must be replaced by the use of power-switching semiconductors and circuits. Research is required for power semiconductors with more current and voltage capacity than experimentally available now. It also means higher back voltage for silicon and similar rectifiers.[1]

The following list (items 6 to 10 inclusive) of research and techniques are additional examples presented by Dr. Harvey Brooks, dean of engineering and applied physics, Harvard University:[2]

6. Materials Preparation and Properties, Including the Systematic Study of Classes of Related Elements and Compounds. Experience with Ge (germanium) and Si (selenium) has demonstrated the tremendous effort involved in obtaining materials of really high purity. It has also demonstrated how much can be learned when many laboratories concentrate on the study of one or two materials which can be highly controlled and specified. In this respect, we have made more progress with elemental semiconductors than with either metals or insulators. It is only now being appreciated what could be learned if we concentrated similar attention on the purification and study of a particular metal. In the field of insulators and very large band-gap semiconductors, we are only just beginning to study materials of really high perfection and purity.

There is an equally important aspect of materials study which has been largely neglected in this country. This is the systematic study of the physical and chemical properties of groups of related compounds. The 3–5 intermetallics are an example where this has been done to some extent, but even in this case there has been little systematic study of binary alloys of these compounds. In general, the theory of solids has not been adequate to anticipate the properties of new compounds or even solid solutions, although the semiempirical rules of inorganic chemistry, based on rudimentary ideas of valence, have been quite valuable as a guide in looking for new materials. One of the major tasks for the future is that of establishing the connection between valence and chemical concepts on the one hand and energy band theory on the other, and it is in this area that experimental study of homologous compounds should be most fruitful. Such systematic studies are almost certain to lead to new electronic properties of practical importance.

Systematic studies on groups of materials will not be practical without improved methods for preparing materials of highly specified composition. There is need for more intensive effort on the science underlying material preparation in addition to the production of specific materials. This science includes the origin of imperfections, the theory of purification, the statistical

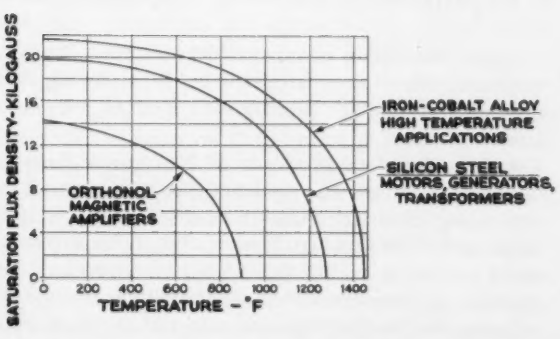

Fig. 11. Decrease of saturation flux density with temperature for various magnetic materials (Curie effect).

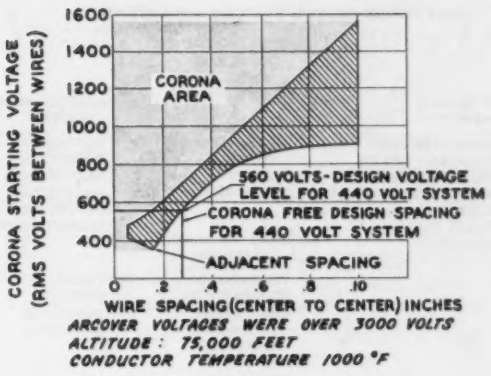

Fig. 12. Corona starting voltage for parallel insulated wires.

mechanics of inorganic compounds, including what factors affect deviations from stoichiometry, etc.

7. The Electronic Properties of Solids Under Very High Magnetic Fields. The highest steady magnetic field available in the laboratory is 100,000 oe (oersteds), but engineering studies indicate that steady fields as high as 500,000 oe should be feasible in small volumes. In short pulses fields over 10^6 oe have been achieved. However, the exploration of the electronic properties of solids in these high fields has only just begun. From theory we can anticipate that many new experiments will be possible, of which only a few will be mentioned here. The exchange forces responsible for the collective behavior of the spins in ferromagnetic materials are characteristically of the order of 10^5 to 10^6 oe; hence external magnetic fields in this range can be used to decouple the spins in such systems, and therefore to explore exchange forces in far greater detail than is otherwise possible. In a magnetic field of 5×10^5 oe, the cyclotron resonance frequency for a free electron is of the order of 10^{13} cps, corresponding to an electromagnetic wavelength of 40 microns, which lies in the infrared. Thus, magnetic fields of this magnitude open the possibility of observing cyclotron resonance optically. The importance of this lies in the fact that characteristically the time between electronic collisions in solids at room temperature is of the order of 10^{-13} seconds, so that even at room temperature an electron can make a full orbit in the magnetic field. This opens the possibility of studying the band structure of many solids which cannot now be studied in detail experimentally. Fields of this magnitude place ordinary Zeeman splittings in atomic or ionic energy levels in the submillimeter range of electromagnetic radiation, and similarly ferromagnetic resonance is brought into this range. This offers possibilities in the generation and detection of radiation in this inaccessible range of the electromagnetic spectrum.

8. Bridging the Gap in the Electromagnetic Spectrum between Microwaves and the Long Wavelength Infrared. The availability and usefulness of this radiation correlates closely with high magnetic fields. We know

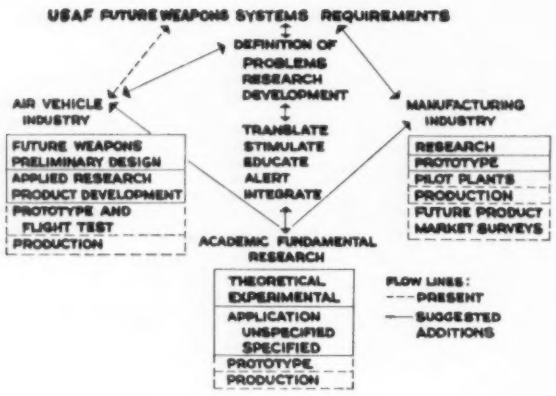

Fig. 13. Flow chart for defining and co-ordinating research in universities and research institutions.

that exchange resonance in ferrimagnetic and antiferromagnetic materials are characteristically in this range of frequencies. More generally, however, new radiation has always led to a new spectoscopy, and we may expect this to be the case for submillimeter radiation as well.

9. Microacoustics, i.e., The Study of the Interaction of Solids with Acoustic Energy Having Frequencies in the Microwave Range and Wavelengths in the Micron Range. Acoustic waves have the big advantage that they penetrate readily into conducting solids, and thus do not exhibit a skin effect. In general, such waves are accompanied by electric fields, so that they provide a means for getting high-frequency electric fields into large single crystals. This technique has already proved its usefulness in studying acoustic-electronic interactions in metals at low temperatures. If acoustic radiation can be generated in the microwave frequency range, it may be possible to study acoustic-electronic interactions at higher temperatures, and hence to explore the band structure of a wider variety of materials.

10. High Pressure and Temperature as a Means of Synthesizing New Materials, Metastable under Ordinary Conditions, and the Extensions of Ultra-High-Pressure Techniques to Low Temperatures. The production of synthetic diamonds and of borazon illustrates how new materials can be formed by cooling a phase formed at high temperature and pressure, so that it remains metastable due to its inability to transform at the lower temperature. In principle, high-pressure phases produced at room temperature could be retained metastably by cooling to very low temperatures, and this offers a possible new technique for studying such phases in much more detail than is feasible inside the high-pressure apparatus, and also for studying the kinetics of phase transformations. It is even conceivable that such metastable phases might have electronic properties which could be exploited. Certainly the addition of lattice parameter as a variable in the systematic study of materials can add a great deal to our understanding.

Challenge to Research Institutions

During the past 5 years, most of the examples listed have been discussed with the electrical engineering departments of several academic institutions including the following: University of California at Berkeley; University of Washington at Seattle; Washington State University at Pullman; Purdue University, Lafayette, Ind.; University of Michigan at Ann Arbor, Mich.; and Massachusetts Institute of Technology (MIT) Cambridge. The faculty reaction varies from surprise to partial realization that these problems are so important to the air- and space-vehicle industry; that the curriculum that has been used up to now needs to be reorganized to meet the challenge of graduating appropriately trained engineers and scientists; and that much of the graduate research could be reoriented toward the problems and techniques illustrated. Fig. 13 shows the suggested lines of co-ordination to alert the academic and industrial research institutions. Efforts to do this are underway via a large number of bewildering organizations and agencies. It would appear that there is a requirement for a more orderly approach.

A reorganization of the curriculum was started at MIT in 1954 in the electrical engineering department. The first 2 years place much more emphasis on the fundamentals of physics, chemistry, and mathematics. The approach used by this private institution may be different from what public universities can do. Yet it is an example of what is being done.

REFERENCES

The nature of the bulk of this paper precludes the detailed listing of references. However, the following items were used as source material for some of the data presented:

1. Direct Engine-Driven Unconventional Electric System, Karl Martinez. SAE National Aeronautic Paper, Los Angeles, Calif., Sept. 30–Oct. 5, 1957.

2. Scientific Opportunities, Harvey Brooks. National Security Industrial Association—Air Research and Development Command Conference on Molecular Electronics, Washington, D. C. Nov. 13-14, 1958.

3. Molecular Science and Molecular Engineering (book), A. R. von Hippel, et al, Technology Press of MIT and John Wiley and Sons, Inc., New York, N. Y., 1959.

Equipment Leasing on Increase

Long-term leasing of production equipment by electrical and electronics manufacturing firms during 1959 reached a total of $23.6 million, a gain of 39% over 1958.

Robert Sheridan, president of Nationwide Leasing Company, Chicago, Ill., predicted that equipment leasing in the electrical industry would double in 1960 because of three factors: (1) more equipment manufacturers are using leasing as a sales tool to move their products; (2) more companies will lease their equipment to avoid the pinch of tight money; and (3) more companies will be affected by the increasing technological progress which is speeding up machinery obsolescence.

Formex- and Paper-Insulated Wires in Transformer Oil

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WIRE INSULATION is probably the most important component of the insulation system used in oil-immersed transformers. Its strategic location—in contact with and separating turns—results in the insulation operating at temperatures very near that of the conductor which is the maximum temperature encountered in the transformer. Therefore, its thermal aging characteristics are of considerable interest.

Two types of materials which have been used extensively are paper and film insulations. Paper has been used successfully since the inception of the liquid-immersed transformer and is still the "standard" for many transformer applications. Formex (General Electric trademark for polyvinyl formal film insulation) first made an appearance in oil-immersed transformers in 1939. Unpublished thermal evaluation data obtained at that time showed Formex to be definitely superior to paper in its thermal degradation properties. Good abrasion and heat shock resistance, high dielectric strength and over-all superior performance have established Formex as an important advance in insulation technology.

Thermal aging data was obtained on manila paper and Formex wire insulation systems under accelerated thermal conditions while in environments similar to those found in modern transformers.

The industry has developed a standard test procedure for thermal evaluation of film-insulated round wire, aged in air—the familiar "twisted pairs." Although AIEE is now working on one, no similar standard has been established for rectangular wire, and none for aging in liquid environments. Therefore, it was necessary to devise a simple sample, a container for aging in oil under transformer environmental conditions and a test to determine the degree of aging. The test procedure used in this study was to provide a sufficient number of samples so that several could be tested to electrical breakdown at each of many selected aging periods. Thus, knowledge of the progression of aging was gained

In the unaged condition, the 6-mil Formex insulation has a slightly lower dielectric strength than the 12 mils of paper with 4 mils of cotton; however, on a volts-per-mil basis the dielectric strength of Formex is 2¼ times that of paper. The dielectric strength of the paper insulation, aged at 125 C, decreases with increasing aging time; the superiority of Formex is seen throughout the aging period. No significant decrease in the strength of Formex is seen even after 520 days, while the paper was weakened to about 15% of its initial strength. Similar results were obtained on samples aged at 150 C and 175 C but of course end-of-life occurs progressively sooner. Data were obtained, at all three aging temperatures, with testing pressures of 50 and 1,500 psi, and only small differences were encountered with all three temperatures.

These aging data were analyzed by two end-point criteria. First, by determining the time required to degrade to 50% of initial strength. These are plotted on special graph paper having "log life" vs. "reciprocal absolute temperature." The best fitting straight lines, when extrapolated to 35,000 hours, show the values of hottest spot temperatures at that time to be 127 C for Formex and 113 C for paper, a difference of 14 degrees. Further extrapolation to 105 C indicates that manila paper should have a life of about 17 years and Formex many times that. A similar analysis was made by determining the time required to degrade to 3,000 volts. Formex at 35,000 hours appears 21 degrees higher than paper. The life of paper at 105 C should be about 20 years and Formex many times that of paper. Since both of these criteria are well in excess of the normal turn-to-turn voltage, these data substantiate the excellent service records of transformers with paper turn insulation and show Formex could be operated conservatively 10 C hotter than the paper for normal life expectancy.

In conclusion, a sample construction and container have been developed to permit aging of rectangular wire in simulated liquid-immersed transformer insulation systems. The method permits evaluation of life of both film and served insulations and is offered for study to the AIEE Working Group considering a standard method for testing wire insulations used in liquid-immersed apparatus.

The accelerated aging data reveal: (1) The life of paper turn insulation obtained in these tests agrees well with the classification of the material; (2) There is negligible effect of pressure between conductors during testing; (3) Formex, when unaged, has a breakdown stress of 2¼ times that of paper and continues to show superiority throughout the life; (4) Formex can be utilized, conservatively, at hot spot temperatures 10 C higher than paper; or (5) Formex can be expected to yield considerably longer life than paper when used at the same hot spot temperature.

Digest of paper 59-281, "Accelerated Aging Characteristics of Formex and Paper Insulated Wires in Transformer Oil," recommended by the AIEE Transformers Committee and approved by the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959. Published in AIEE *Transactions*, pt. III *(Power Apparatus and Systems)*, vol. 78, Dec. 1959. pp. 1,202-07.

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Modern Instrumentation in a Short-Circuit Research Laboratory

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A description of the outstanding features of this revised short-circuit facility with particular emphasis on the expansion and modernization of the instrumentation and controls in the laboratory.

WITHIN the past year, the Short-Circuit Laboratory of Line Material Industries was moved from its initial location in a crowded industrial town to a remote location in the open country. The removal and re-installation of this short-circuit facility presented an excellent opportunity to revise and revamp the control and instrumentation of the laboratory and make it a more efficient test and research tool as applied to development of power- and distribution-class equipment. Furthermore, with the large land areas associated with this new installation (Fig. 1), it is now possible to plan and carry out tests on buried cable,

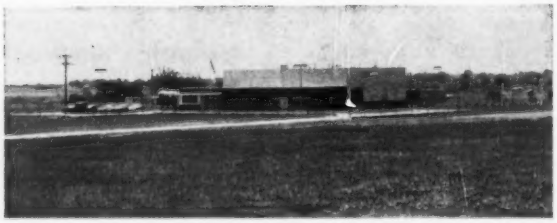

Fig. 1. General view of short-circuit laboratory.

aerial cable, and other actual power system configurations which require large unrestricted areas.

HISTORY

THE SHORT-CIRCUIT LABORATORY was initially constructed in 1946 adjacent to the parent factory in South Milwaukee, Wis., to provide a test ground for the development of distribution-class equipment. With the passage of time, it became evident that to obtain the fullest utilization of this test facility, the laboratory would have to be moved. In order to provide the greatest flexibility and freedom from interference, a 134-acre site was chosen adjacent to a railroad right-of-way. With this new location, it is possible to test all products far beyond the ranges previously covered without jeopardizing laboratory equipment, neighboring buildings, or neighbors when the testing of a device is carried to destruction.

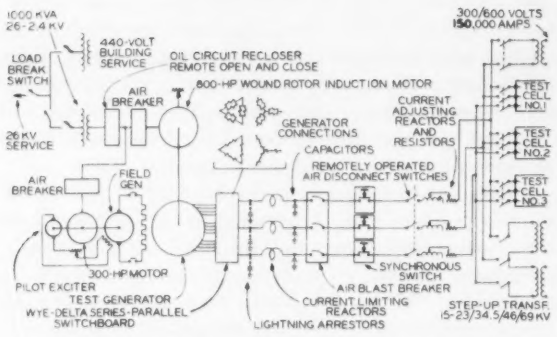

Fig. 2. Simplified diagram of power and test circuits.

BASIC LABORATORY FEATURES

A simplified circuit diagram of the Short-Circuit Test Laboratory is shown in Fig. 2. The major equipment indicated consists of: (1) substation, (2) short-circuit generator, drive motor, and field exciter, (3) 1,500-mva backup air blast breaker, (4) synchronous closing switch, (5) circuit loading equipment, (6) specimen test cells, (7) outdoor capacitor bank for loading of test circuits, (8) two 16,667-kva single-phase short-circuit transformers, (9) one single-phase 10,000-kva 600-volt transformer.

Substation. The laboratory substation (Fig. 3) is fed from a 26-kv feeder, and supplies 2,400-volt 1,000-kva 3-phase power for the operation of the heavy machinery. Building service is supplied at 480 volts and is stepped down at the load to 120 volts by dry-type transformers for lighting and other building auxiliary equipment.

Generator and Auxiliary Equipment. The short-circuit generator (Fig. 4) is a high-speed 60-cycle test generator specially designed to produce 3-phase short circuits in excess of 500,000 kva. This generator rotates at 3,550 rpm and is driven by a special 800-hp wound-rotor induction motor. As in the case of most short-circuit generators, it is the conversion of the stored mechanical energy in the whirling rotor which produces the extremely large short-circuit currents necessary for short-circuit studies.[1] The basic generator voltages are 15,000 and 7,500 when connected in Y,

Essentially full text of a conference paper CP59-1286, presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 11-16, 1959. Recommended for publication by the AIEE Switchgear Committee.

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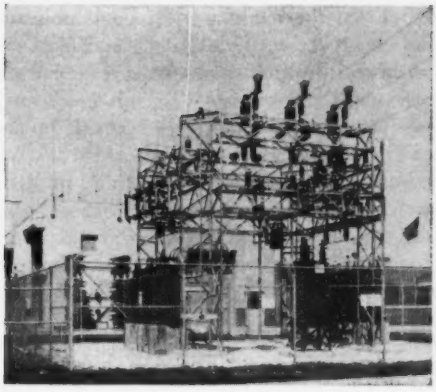


Fig. 3. Substation supplying power to laboratory.

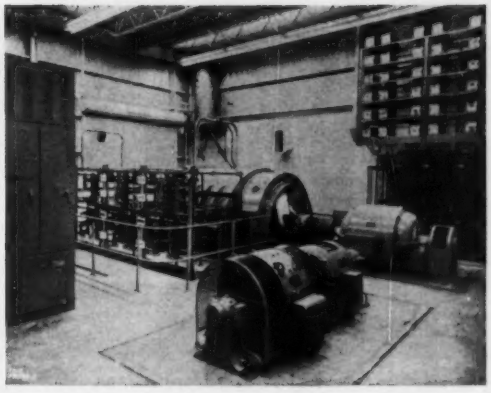


Fig. 4. Short-circuit generator, driving motor, and exciter.

and 8,660 and 4,330 when connected in delta. Generator excitation is accomplished by a 250-kw exciter.

A high-speed short-circuit generator was chosen for the job of testing distribution and subtransmission power equipment in preference to less expensive short-circuit test transformers for three reasons. First, it is possible to control the test voltage and place it at any precisely defined increment throughout the range of 1,500 to 15,500 volts. Second, the X/R ratio of the generator and that of the loading reactors is so high that test circuits having extreme recovery voltage characteristics can be obtained. By means of shunt capacitance, it is then possible to adjust the severity of the circuit recovery voltage to the desired level. Third, the equipment may be operated at any hour of the day or night at maximum capacity without disturbing the power system which feeds the laboratory. This latter point is used to good advantage as the laboratory is quite often operated for two 8-hour shifts per day.

Power Circuit Breaker, Synchronous Closing Switch, Loading Equipment. Power is fed from the test generator to the air-blast breaker as shown in Fig. 2. This breaker, rated at 1,500 mva, acts as the main circuit protection for the generator and is called upon to operate in case the specimen undergoing short-circuit test fails to clear the circuit, or it is opened on those tests which entail applying short-circuit currents to a device which is not intended to interrupt currents. In the latter case, the circuit breaker is called upon to clear the circuit after a definite controlled number of cycles have elapsed. From the circuit breaker, power is fed to a synchronous closing switch (Fig. 5). The element is the last switch to be closed in the test circuit and it initiates the flow of short-circuit current. This switch is electronically controlled so that one, two, or all three poles may be closed independently or simultaneously. From the synchronous switch, power is fed to the (electric) loading equipment (Fig. 6), where connections are made to introduce the desired value of inductance, resistance, and if necessary, shunt capacitance. These elements control the circuit impedance, power factor, and the rate of rise of recovery voltage.

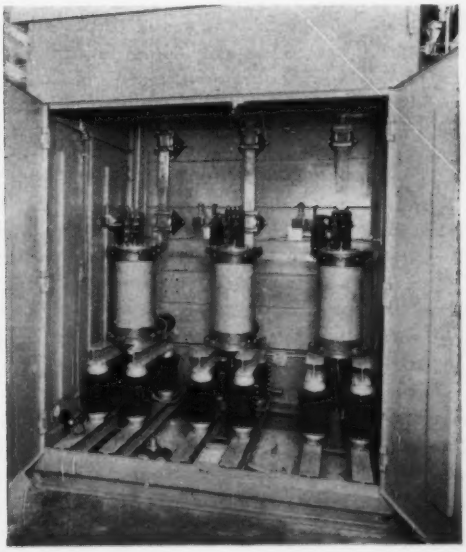


Fig. 5. Synchronous closing switch.

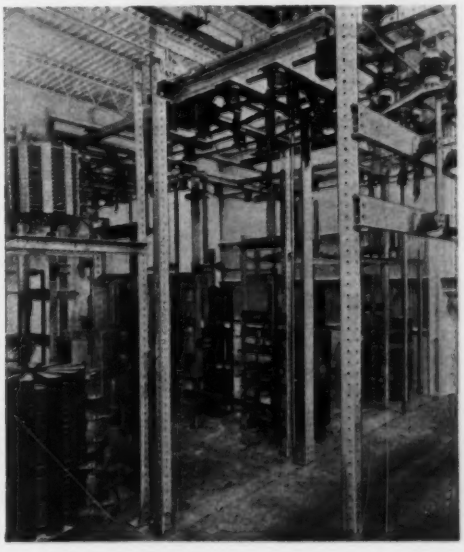


Fig. 6. Electrical loading reactors and resistors.

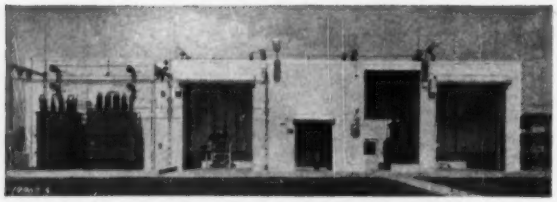


Fig. 7. General view of laboratory test cells.

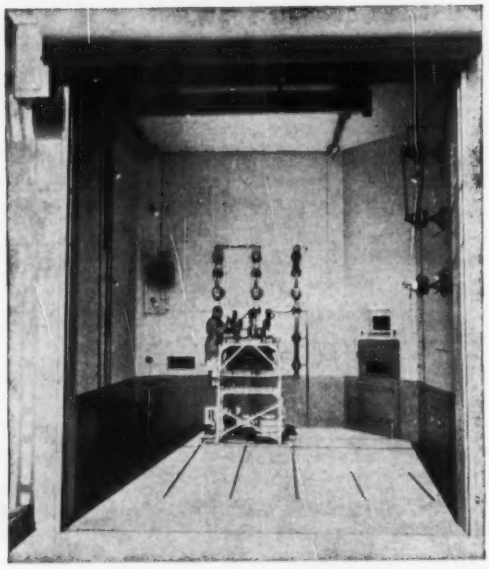


Fig. 8. Interior view of a typical test cell.

Fig. 9. Control center showing television monitors.

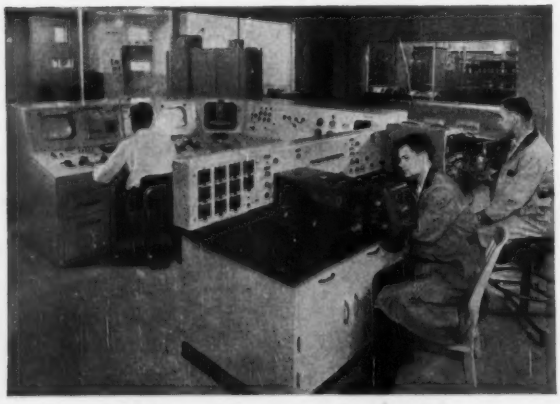


Fig. 10. Control center showing instrumentation.

Test Cells. From the loading equipment, power is fed to any of the three test cells (Fig. 7). These test cells have overhead rolling steel doors that can be opened to provide a test cubicle which is completely enclosed on five sides and vented to the outside on the sixth. The walls, floor, and ceiling of the cells are made of approximately 1-foot-thick concrete, and are heavily reinforced with steel. Bullet-proof glass is used in all viewing windows and all the necessary metering leads are brought into armored boxes within the cells as shown in Fig. 8.

High-Voltage Test Transformers. Two special, low reactance (1.7% impedance), 16,667-kva transformers are available at a location south of the electrical loading room, extreme left in Fig. 7. Each transformer has a nominal voltage rating of 69/46/34.5/23 to 15.0 kv. When these transformers are connected in series, a single-phase voltage of up to 138,000 volts is available, or when they are connected in open delta, a 3-phase voltage of up to 69,000 volts may be obtained. The transformers can, of course, be operated singly or in parallel. The output of these transformers may be fed into any of the test cells or may deliver power to test specimens mounted in the open area adjacent to the test cells.

High-Current Test Transformer, Capacitor Bank. A 5% impedance, 10,000-kva short-circuit test transformer is available for single-phase tests at high currents and low voltages. The output of this transformer is normally 600 volts, but may be connected to obtain a 300- or 1,200-volt output. Currents up to 150,000 amperes asymmetrical can be delivered. This transformer is shown in the center of Fig. 7.

A high-voltage capacitor bank, capable of operating up to 69 kv, is shown at the extreme right of Fig. 7. This bank has a nominal 7,200-kilovar capacity and can be expanded to meet testing requirements by merely adding standard commercial capacitor blocks adjacent to the existing structure.

An observation building, located 100 feet south of the test cell area, provides a convenient location for positioning photographic equipment, television camera, and observers who may wish to view the tests directly. This observation building also houses the water supply for the laboratory.

EQUIPMENT AND PERSONNEL SAFETY

Because of the variety of high-voltage power equipment in use at this site, and the number of people associated with this work, the safety of operating personnel is of primary concern. Since all tests are controlled by the laboratory operator from the main control center (Figs. 9 and 10), a closed-circuit television system is installed with the monitors at this control center. This allows the operator to observe all operating personnel adjacent to and within various test cells and to determine visually that all hazardous areas are clear. Television viewing is supplemented with audible and

visual warnings throughout the building and in the outdoor test area adjacent to the test cells. Conventional electric door interlocks are applied to all critical access doors, and all enclosed bus run areas are locked by a single key which must be in the parent lock in the control console before power can be applied to any of the high-voltage equipment.

Another function of the closed-circuit television system is to allow the operator to view a test from two directions. On one monitor, the specimen can be viewed by a television camera located in the observation building using either a conventional, wide angle, or telescopic lens (Fig. 11). On the other monitor, the specimen can be viewed by a television camera (Fig. 12), located at the required test cell viewing port within the building. This camera is equipped with a "Zoom" lens to give the desired close-up view.

Safety of electric equipment in the laboratory is likewise a problem since the normal function of the laboratory is to produce short circuits; conventional overcurrent protection is obviously unsuitable. The generator is protected against internal faults by differential relays. All bus runs, breakers, switches, and other vulnerable areas external to the machine are protected by an extensive system of photoelectric control monitors designed to open the generator field breaker at the first indication of arcing.

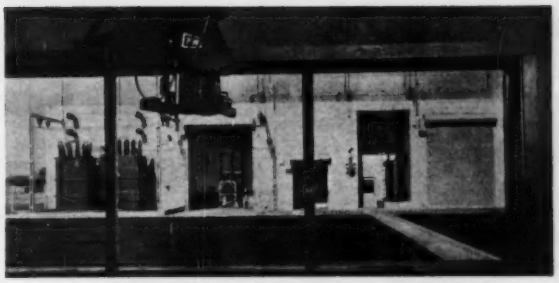


Fig. 11. Television camera in observation building.

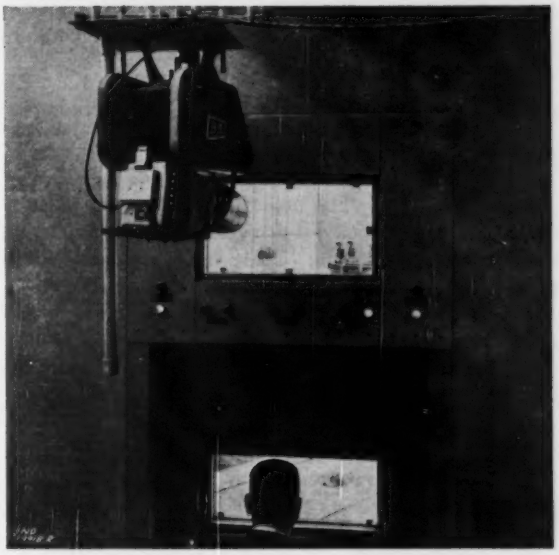


Fig. 12. Television camera at test cell viewing port.

LABORATORY INSTRUMENTATION AND CONTROLS

Test Sequence Control. Three types of sequence timing devices are used because of the wide variety of timing and synchronizing problems encountered in short-circuit research:

1. Coarse timing control for noncritical devices such as warning horns, oscillograph motors, and auxiliary equipment is accomplished by a synchronous, motor-driven cam-operated multipole switch.

2. Timing within half-cycle increments is obtained by a cascade relay circuit for the operation of devices such as the synchronous closing switch and for synchronizing magnetic oscillographs, high-speed photographic equipment, and similar devices.

This cascade relay timer consists of a series of low-inertia multicontact high-speed a-c relays and rectifiers connected as shown in Fig. 13. In operation, Switch S_1 is closed, allowing relay R_1 to close when current of the correct polarity flows through rectifier Z_1. Contacts of relay R_1 close in less than 1/4 of a cycle and will remain closed as rectifier Z_1 is now bypassed by relay contact 1R-1. Relay R_2 cannot close during this half cycle as current is blocked by rectifier Z_2. After the polarity reverses, rectifier Z_2 conducts and relay R_2 closes, bypassing rectifier Z_2. This process is repeated on each successive relay.

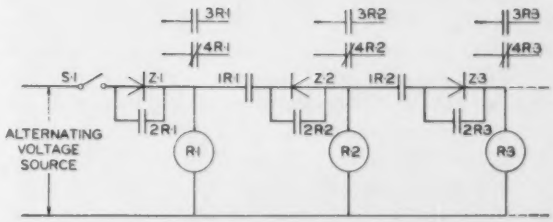


Fig. 13. Cascade relay (half cycle) timer.

Thus, each relay represents 1/2 cycle of time delay and the auxiliary contacts of each relay are used to open or close various control circuits. The maximum interval of time that can be controlled is limited only by the number of relays connected in the series. For this laboratory, 50 relays provide a satisfactory operating range. Although there may be slight variations in the closing time between relays, these variations are not cumulative.

3. For precise timing, an electronic control is used. This timer opens the back-up and field breakers after any preset number of half cycles of current. This control is essential for those short-circuit tests involving devices which are not designed to interrupt fault current. It is equally important in protecting arc interrupting devices from serious damage if they fail to clear short-circuit current during development tests. Another

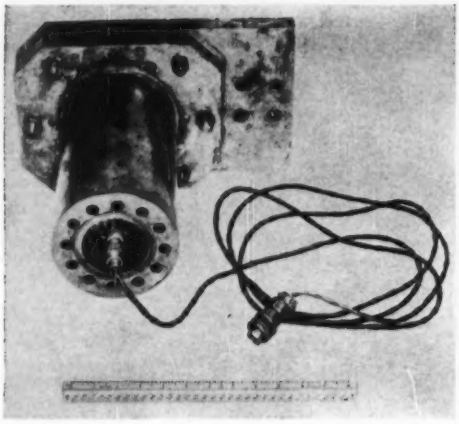


Fig. 14. A 75,000-ampere coaxial current shunt.

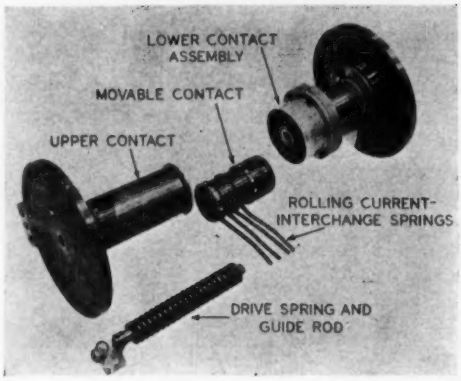


Fig. 15. Exploded view of synchronous switch.

feature of this control is that it gives the operator an instantaneous, visible read-out of the number of half cycles of current flow on three decade-counter tubes.

Current Shunts. The metering of 60-cycle phenomena is generally carried out using conventional magnetic oscillographic equipment. These oscillographs are fed from either current shunts, current transformers, capacitance or resistance potential dividers, or potential transformers located in the various test cells. Since many measurements in short-circuit testing involve asymmetric currents, the use of current transformers is difficult, and their accuracy is questionable because the d-c component of these current waves produces saturation of transformer iron. Therefore, current shunts are used for all measurements of asymmetric current waves.

Three ranges of current shunts have been constructed, allowing measurements throughout the range of 1,500 through 150,000 asymmetric amperes. The coaxial design of these shunts is based upon the ideas proposed by J. H. Park of the National Bureau of Standards.[2] A special 4-terminal resistance element is machined out of a solid billet of copper-nickel alloy. The temperature characteristics of this material are such that the resistance increased no more than 0.1% over a 100 C rise in temperature. The volume resistivity of the material and the size of the element were designed so that at maximum rating, the temperature rise of each shunt would not exceed 110 C. The oscillograph metering leads are completely coaxial with respect to the concentric flow of high current. Thus, the driving signal received at the oscillograph is practically unaffected by either the temperature of the shunt or electromagnetic effects of currents which flow through the shunt. The small physical size of the shunts is illustrated in Fig. 14.

Recovery Voltage Instrumentation. High-frequency recovery voltage phenomena is metered by means of high-voltage capacitance dividers. The design of these dividers is based on known principles,[3] and the frequency response of these units was verified by sine wave and impulse functions from a transient analyzer. The

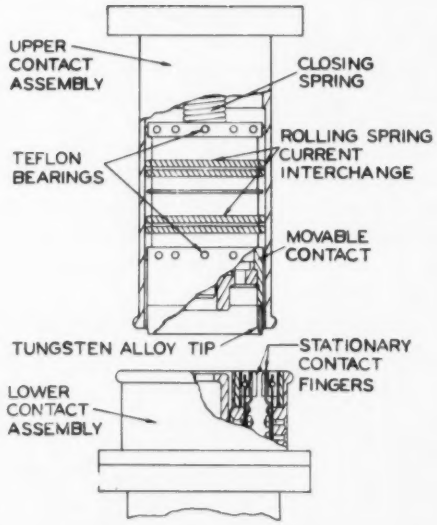


Fig. 16. Cutaway view of synchronous switch contact assemblies in open position.

output of these dividers is fed to a high-frequency, dual-channel oscilloscope employing a driven sweep. A Polaroid camera employing a 1:1 lens is used to photograph the desired transients. A special synchronization unit is employed to provide initiation of a scope sweep a few electrical degrees before each current zero.[4] Although multiple zero traces appear on the scope screen during the flow of fault current, these traces will fall on top of each other forming a bright zero line and will not interfere with the recovery voltage picture which appears at the time the specimen clears the circuit. Once the specimen has cleared, the synchronizing pulses are automatically removed.

Synchronous Closing Switch. One very important element in the operation of any short-circuit laboratory is an accurate and reliable synchronous closing switch. The one constructed for this laboratory employs three independent poles in which the high-speed closing contacts are operated within insulating chambers under

150 pounds internal air pressure. The effect of this air pressure is to reduce pre-arcing as the contacts close.[5] Fig. 15 shows the internal parts of the switch. The combination of the heavy driving spring and the small mass of the moving contact allows the switch to close in less than 1/100 of a second. This high-speed closing, plus the shape of the moving contact, further helps to reduce the time of pre-arcing and aids in maintaining consistent operation. Another feature is the compact construction which allows the movable contact, drive spring, stationary contact, and recoil shock absorber springs to be contained in a single chamber.

All moving contact arcing tips and stationary contact fingers are made of silver-tungsten to minimize maintenance. Electric contact erosion is kept to a minimum by virtue of the large arcing tip area of the moving contact and the multiplicity of stationary contacts which are both internal and external to the moving contact. The switch is capable of establishing short circuits in which current is in excess of 130,000 asymmetrical amperes.

The current interchange associated with the moving contact is worthy of note since a unique rolling spring principle is employed (Figs. 15 and 16). This interchange takes advantage of the great difference between rolling and sliding friction and provides extremely high current-carrying capacity with high-contact pressure between the upper stationary and the moving contact. Only about a 5-ounce force is required to move the entire dynamic system of each pole. Because of this low friction, there is very little mechanical wear on the copper alloyed parts despite the high velocity and the high electric contact pressure.

The electronic controls used to actuate the synchronous switch are fed from potential transformers connected in open delta at the terminals of the generator. As shown in Fig. 17, the generator voltage is fed to Selsyn phase shifters, to peaking circuits, and then to a phase-sequence selector circuit. This circuit then triggers the thyratrons which in turn energize the synchronous switch trip coils. The sequence selector circuit allows independent closing of any selected switch pole, simultaneous closing of all three, or the initial closing of a selected pole followed by delayed closing of one or two poles to produce any desired single-phase or 3-phase asymmetry.

The switch is fully interlocked so that it cannot be operated if the cubicle doors are opened, if the air pressure is low in the pole pressure chambers, or if the lift mechanism or moving contact is not in the proper position. The over-all accuracy of this device is ± 3 electrical degrees at all voltages up to 15.5 kv.

SUMMARY

By virtue of the relocation of this short-circuit laboratory, it was possible to modernize the instrumentation and control and provide a very efficient and flexible research tool.

In rebuilding, particular emphasis has been placed on the design and construction of electric sequence timers, accurate measurement of high short-circuit currents by means of low-resistance coaxial current shunts, and the accurate recording and synchronization of recovery voltage phenomena. A flexible, compact, electronically controlled synchronous switch is described employing a high-speed closing contact which gives precise independent closing on all three phases.

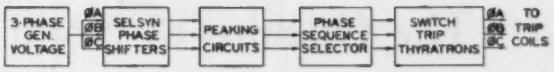
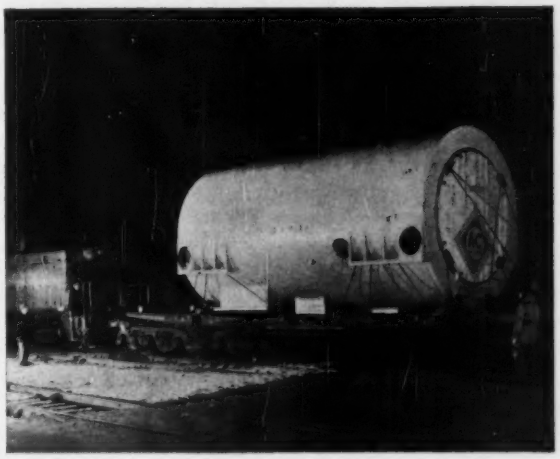


Fig. 17. Block diagram of synchronous switch control.

REFERENCES

1. Turbo Generator for Use in Short-Circuit Testing. Sterling Beckwith. AIEE *Transactions*, vol. 70, 1951, pp. 2,016-19.
2. Shunts and Inductors for Surge-Current Measurements. J. H. Park. National Bureau of Standards, R. P. 1823, vol. 39, Sept. 1947.
3. High Voltage Laboratory Technique (book). J. D. Craggs, J. M. Meek. Butterworths Scientific Publications, London, England, pp. 293-4. 1954.
4. An Oscillograph for Recording Transient Recovery Voltages. W. G. Hoover. AIEE *Transactions*, vol. 65, 1946, pp. 1,086-91.
5. Insulation Phenomena of Compressed Air. L. D. McConnell. AIEE CP 57-725, 1957.

250-Ton Stator



Bound for the T. H. Wharton station of the Houston Lighting & Power Co., is this 250-ton generator stator, heaviest single shipment ever made from Allis-Chalmers West Allis (Wis.) Works.

Because of the stator's weight, and height of almost 18 feet from the rails, the special steel decked flatcar furnished by the Pennsylvania Railroad was restricted to a speed of no more than 25 miles per hour.

The generator is for Allis-Chalmers 220,000-kw Unit 2 at the utility's outdoor power plant north of Houston, Texas.

The Calculus of Nonuniformly Spaced Variables

GABRIEL KRON
FELLOW AIEE

IN the conventional calculus of finite differences the n sets of k independent variables $x^a_{(1)}, x^a_{(2)} \ldots x^a_{(k)}$ are assumed uniformly spaced along each of the k axes of a rectangular frame. Occasionally nonuniform spacings are also assumed, but only along one dimension.

In the proposed calculus the n sets of k independent variables (representing, say, experimental data) are considered as n arbitrary points scattered around in a k-dimensional Euclidean space. These points are used as anchors for the construction of a new type of reference frame. The frame consists of a network of branches connecting neighboring points; plus a network of planes connecting neighboring branches; plus a network of cubes connecting neighboring planes: and so on, until a network of k-dimensional cubes (k-cells) connect the neighboring k-1-dimensional cubes. These k networks are also interlinked with each other, forming a polyhedron.

In the conventional electric circuit models of partial differential equations, of elastic structures, etc. the dependent variables y_a and their differences of various orders are considered as currents and voltages superimposed upon the underlying network. However, in the present case of nonuniformly spaced independent variables, the dependent variables y_a (one or more sets) and their differences of various orders are no longer considered as electric currents and voltages. Rather, they are assumed as electromagnetic waves propagating across the complex of interconnected 0-, 1-, 2-. . .to k-dimensional networks, leaving in their wake electric charges and magnetic poles. These generalized waves obey the generalized Stokes Theorems of combinatorial topology. By subjecting the k underlying networks, as well as the superimposed electromagnetic waves, to various manipulations so familiar to electrical and electronic engineers, much of the ingredients of a new nonuniform calculus are already available for the study of a wide variety of problems in advanced numerical analysis, statistics, and physics.

Of course, the paper submits only a mechanism, not mathematical proofs of the mechanism. The proofs lie in the physical background of the concepts. Complete algebraic diagrams developed for a linear graph are extended to show the tensorial concepts and transformation theory to be used in connection with the entire complex of k networks. A proposed path for the electromagnetic waves, to be assumed in simple k-dimensional interpolation problems by Newton's formula, is also shown. Eventual solution of extensive problems in nonuniform k-dimensional curve-fitting, also smoothing of experimental data, among other things, is anticipated, as well as k-dimensional spectral analysis. Both deterministic and probabalistic interpretations are expected to be used now for multidimensional problems of systems with sampled data.

The physical models, used systematically by the author in all his works, offer certain advantages that purely mathematical equations do not imply. For instance, in partial differential equations the model corresponds to the physical picture that mathematicians have established for a finite material block $\Delta x \Delta y \Delta x$, before going to the limit to establish the partial differential equations. As another example, the electric circuit models of a mechanical structure give easy access to all the internal stresses and strains in the system.

Moreover, because of the availability of a model, it is comparatively simple to solve large physical systems in small installments by tearing the system apart into an arbitrary number of small structures and solving each separately. The constraint forces appearing at the points of tear are available outright by inspection, without any search.

In general, it may be said that the purpose of an electric circuit model is to endow the formless, amorphous equations (the "algebraic structure"), with an underlying "topological structure." The latter keeps the algebra within proper bounds and directs its course of manipulation and solution.

Of course, the establishment of a structure or model for a physical system is comparatively simple. Often the system itself is its own model (as in electrical networks). In mechanical and dynamical systems, however, it is necessary to endow the underlying topological structure with a superimposed tensor structure in place of a scalar one, before the process of solution begins.

In economic and statistical problems, however, the underlying structure is hardly discernible, or is entirely absent. Thus, it may be said that the primary purpose of the theories of economics, of statistics (and of numerical analysis) is to take a given set of amorphous, uncoordinated data and to "breathe life" into them; to endow the numbers with some organization, some "structure." This paper is an attempt to do just that; namely, to set up an underlying topological structure—as well as a superimposed algebraic structure—for a set of arbitrary numbers. The only assumption made about the given set of numbers is that they belong to an unknown function that possesses derivatives of appropriately high orders at the given points.

Digest of paper 58-787, "A Generalization of the Calculus of Finite Differences to Non-Uniformly Spaced Variables," recommended by the AIEE Basic Sciences Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting and South Central District Meeting, Atlanta, Ga., April 8-10, 1959. Published in AIEE *Transactions*, pt. I (*Communication and Electronics*), vol. 77, Sept. 1958, pp. 539-44.

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High-Capacity Isolated-Phase Buses

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THE ISOLATED-PHASE BUS, which has become the standard method for connecting power generators to transformers, has presented some problems on inductive heating of adjacent material, and there has been some question of the possibility of pressurizing the installed bus to exclude dust. Laboratory tests on these buses, run at 11,000 amperes and 15,000 amperes, and laboratory and field tests on cover tightness have produced valuable statistics for calculating induced heating and for checking cover tightness.

The problem of induced heating in metal adjacent to the bus affects the structural designer and the plant safety engineer. Too much heat in a structural member could accelerate deterioration of the surrounding concrete, and too much heat in an exposed member could be dangerous to personnel. To determine the amount of induced heat in such members, a number of items normally found in generating stations were placed in proximity to the bus and temperature rises were recorded.

A framework of structural members, similar to the normal bus-supporting framework was tested with the beams solidly connected to form a loop and with the joints insulated to prevent circulating currents. With the bus carrying 11,000 amperes, the induced current in the steel loop was measured in excess of 1,200 amperes, and temperature rises in the beams reached 80 C. When the loop was interrupted with insulation so no current could flow, the magnetic heating produced a maximum 30 C temperature rise. When the bus current was increased from 11,000 amperes to 15,000 amperes, the temperature rises in the supporting steel increased about 50%.

To check heating in reinforcing rods, a grid of steel rods was placed above the bus. With the rods connected to each other, forming an electrical loop, rises of 49 C were measured. When the rods were insulated, the rise dropped to 39 C. The test was repeated with nonferrous rods connected to form an electrical loop. Rises as high as 250 C were registered in this nonferrous loop system. All readings shown were made with the main bus carrying 11,000 amperes.

In order to understand the problem of pressurizing an isolated-phase bus, it is necessary to understand the pressures involved. Assuming a completely tight system, the pressure change per degree centigrade of temperature change is equal to approximately 0.1 inch of mercury. If this bus were finally sealed on a relatively cold day, the increased internal temperature caused by electric heating, changes in outside ambient, and changes in barometer pressure could add up to as much as 7 inches of mercury internal pressure.

In laboratory installations, it was possible to assemble a fairly large section of bus so that with a gauge pressure of 1 inch of mercury the leakage of gas would be approximately 1 cubic foot of gas per day for each 100 cubic feet of bus. This test was not subject to the vibrations and temperature changes of an installed and operating bus so the field-installed bus is probably not as tight as the laboratory sample. The successful field installations have operated usually by introducing a positive pressure into the bus each morning and letting pressure build up during the day and fall off at night. Under this system, the amount of new gas introduced into the bus was approximately 2 cubic feet per day per 100 cubic feet of bus.

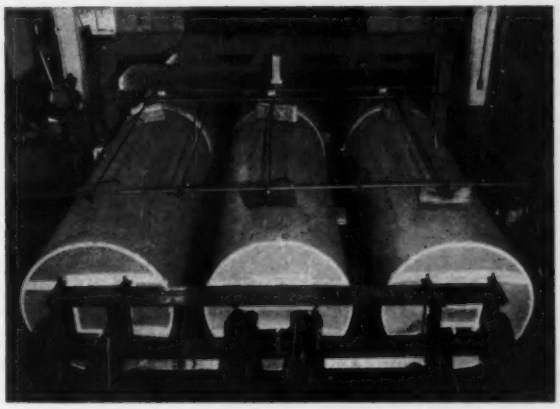

Fig. 1. Electrical test setup of 11,000-ampere isolated-phase bus.

Conclusions drawn from this testing indicate that:

1. Self-cooled isolated-phase buses can be operated at currents up to 15,000 amperes, if operators recognize that high temperatures are not a cause for inspection or an indication of failure.

2. The structural designer must recognize that induced heating will occur, and the effect of this heating in concrete must be considered.

3. Magnetic materials in close proximity to high-capacity buses may have to be isolated from operating personnel to prevent accidental burning.

4. A completely tight bus duct is not practical at present, but buses can be pressurized if sufficient care is taken during installation, and allowances made for temperature variations.

Digest of paper 59-498, "High Capacity Isolated Phase Buses—Laboratory and Field Test Experience," recommended by the AIEE Power Generation Committee and approved for presentation at the AIEE Southeast and South Central District Meeting, Atlanta, Ga., April 8-10, 1959. Published in AIEE *Transactions*, pt. III (*Power Apparatus and Systems*), vol. 78, Oct. 1959, pp. 925-31.

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The International Standardization of Lightning Arresters

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This article briefly discusses the background and development of the International Electrotechnical Commission's Lightning Arrester Recommendations and compares corresponding provisions in the American Lightning Arresters Standard, C62.1—1957.

THE International Electrotechnical Commission (IEC) Publication *99-1*, 1958, entitled "Recommendations for Lightning Arresters. Part I: "Nonlinear Resistor-Type Arresters," marks another step toward the international standardization of electric equipment. It should be noted that the IEC publications are not "standards" but "recommendations" for international use in harmonizing national standards. They are accepted in this sense by the national committees of many countries because they express an international consensus of opinion on the subject considered. In view of this, it is important to understand the Lightning Arrester and other IEC Recommendations and to compare them critically with the corresponding American Standard since it is only natural for American Standards Association (ASA) Sectional Committees to strive for universality by adopting IEC provisions where practical. The United States delegations recognize this and are mindful of it in the compromises necessary to attain international agreement. Although, as shown later, there are minor differences, it is surprising how closely the ASA Lightning Arrester Standard and the corresponding IEC Recommendation already agree. Such agreement is desirable, especially in the matter of definitions. Identical wording in IEC and ASA provisions for factors such as rating or testing of apparatus, however, may be difficult to resolve because of basic differences between American and European systems and operating practices.

THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

THE IEC facilitates the co-ordination and unification of national electrotechnical standards and co-ordinates the activities of other international organizations in this field. It has been operating for more than 50 years since its inception in St. Louis, Mo., in 1904. Since 1947, the IEC has been affiliated with the International Organization for Standardization (ISO) which, through other divisions, prepares recommendations for a wide variety of products and material. Acting as an affiliate of ISO, the IEC has preserved its technical and financial autonomy. Since 1947, annual meetings of IEC have been held at which a growing number of technical committees prepare recommendations for products, general system requirements, and nomenclature.

The United States, as a charter member, has participated in the IEC since 1904 through the U.S. National Committee, which became an affiliate of the ASA after its formation in 1918. Currently there are 36 different IEC product, general systems, or testing procedure committees, many of which may have one or more subdivisions. The United States is actively participating in 90% of these standardizing committees. The ASA Sectional Committee on Lightning Arresters, C62, working in IEC through Technical Committee 37 (TC37), Lightning Arresters, has a vital interest in many other technical committees where areas of interest overlap. Just as ASA committees keep informed as to what is happening in other ASA groups, so the U.S. National Committee to IEC makes it possible for an ASA committee to be advised of what is happening in IEC committees other than the one corresponding to its own activity. For example, the listing in Table I of related IEC and ASA committees indicates the breadth of interest in lightning arrester standardization and the areas in which other groups are kept advised of the over-all problem.

Table I. Related IEC and ASA Committees

IEC Technical Committees	ASA Advisory Committees
TC8: Standard Voltages, Current Ratings and Frequencies TC30: Extra High Voltages TC28: Insulation Coordination	C92: Coordination of Electric Power Apparatus, Equipment, and Systems
TC37: Lightning Arresters	C62: Lightning Arresters
TC42: High Voltage Testing Techniques	C68: Techniques for Dielectric Tests

The IEC Technical Committees 8, 30, and 28, are standardizing voltages, current, frequencies, and basic

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"This paper was prepared by the authors at the request of the ASA Sectional Committee on Lightning Arresters, C62. Since 1953, very shortly after the inception of IEC work on an international arrester standard, the authors have continuously constituted ASA C62's working group on this matter with E. Beck as its chairman, and it is largely due to their informed and diligent efforts that the U. S. point of view has been well prepared as this country's contribution to the completion of the international standard IEC Publication *99-1*, 1958, on NonLinear Resistor-Type Arresters."

H. R. Stewart, Chairman, ASA C62

insulation levels. Technical Committee 28 is also preparing an application guide for lightning protection Technical Committee 42 is reconciling differences in the definition and measurement of impulse wave shapes and in testing equipment, practices, and methods.

Technical Committee 37, Lightning Arresters, started preparing recommendations in 1952. These recommendations to the individual national committees in member countries are intended to be a guide for the preparation of the several national standards so that uniform practices will prevail in all countries. However, when completed, these IEC recommendations are generally conceded the status of an International Standard. The first draft of the Recommendations for nonlinear resistor-type lightning arresters was discussed in Paris, France, in 1952. Succeeding drafts were prepared, circulated, commented on, and discussed at Opatija, Yugoslavia, in 1953; in Philadelphia, Pa., in 1954; and in London, England, in 1955. The recommendations were finally circulated to the national committees for approval under the IEC "Six Month Rule" in 1956 They were unanimously approved by the national committees of 22 countries. After re-editing at Moscow, USSR, in 1957 to include minor changes suggested during balloting, the Recommendations were published as Part I, IEC Publication No. *99-1:* Non-Linear Resistor Type Arresters," in 1958. Work is continuing on the preparation of Part II for expulsion-tvpe arresters. A draft of the expulsion arrester part of the Recommendation will be submitted for approval under the "Six Month Rule" early in 1960.

BASIC DIFFERENCES BETWEEN THE ASA AND IEC STANDARDS

The ASA Standard. The American Standard for Lightning Arresters is essentially a combination of the original Standards issued separately by AIEE and the National Electrical Manufacturers Association. That portion of the Standard dealing with manufacturing factors outlines the several types of arresters that are manufactured and lists the standardized voltage ratings. No effort, however, is made to relate the voltage ratings to system voltages as information of this nature is left for application guides. Basically, the contents of the ASA Standard are written to accomplish a fourfold purpose: (1) standardize voltage ratings; (2) establish classification of arresters; (3) establish uniform tests for performance and durability without specifying the exact test circuits; (4) establish certain uniform mechanical features of the devices.

Noting in the words of the Standard that "the following tests were developed to evaluate the relative performance of arresters," it is evident that the American Lightning Arrester Standard outlines testing standards but does not specify characteristics of performance. Characteristics are purposely omitted because they are too fluid to be stabilized without danger of impeding progress. Left as a competitive factor they are a powerful incentive to new developments. It is, then, the responsibility of the manufacturer to supply to the purchaser information on the protective characteristics of his lightning arresters. With an approved standard, the purchaser has assurance that the data furnished by the manufacturer have been obtained under specified testing conditions. This is the basic purpose of an American Apparatus Standard.

In the preparation of the ASA Arrester Standard, every effort was made to use accepted standard definitions. Also, certain relationships were maintained with other apparatus. For example, the voltage withstand test on arrester insulation is based on values in current use for the voltage class of the system on which the arresters would be used. It is not, however, customary in ASA practice to include application data in the same document as the testing standard.

IEC Standard. The IEC Standard also deals with four major considerations: (1) establishes standard voltage ratings; (2) establishes classification of arresters; (3) establishes uniform tests for performance, characteristics, and durability; (4) states basic application data.

At first glance, these four items seem almost identical with those listed for the ASA standard. There are, however, certain major differences. It will be noted in item 3 that the IEC includes recommended maximum protective characteristics. Also, the application data of item 4 were considered to be more suitable from an international point of view than the inclusion of mechanical features of the devices as found in the American Standard. It is of interest to note that the protective characteristic values given in the IEC Recommendation became obsolete about the same time the document was published.

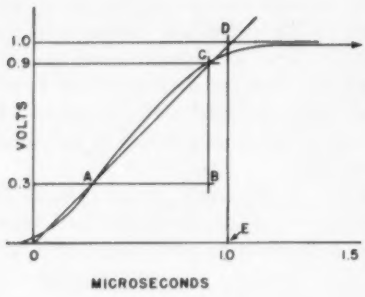
COMPARISON OF ASA AND IEC STANDARDS

Definitions. In general, the definitions common to ASA and IEC are in accord. Some differ in wording but have the same intent. There are differences in nomenclature as compared in Table II.

Table II. Examples of Nomenclature

ASA	IEC
Valve type	Nonlinear resistor type
Discharge voltage	Residual voltage
Crest	Peak
Design tests	Type tests
Ground	Earth

A number of the definitions included in the ASA Standard do not appear in the presently published IEC Standard. Such are, by ASA paragraph numbers: all definitions pertaining to expulsion arresters; characteristic element, par. 2.2; indoor, 2.7, and outdoor, 2.8, arresters; type classification of arresters, 2.9 (this appears in the IEC Standard under Standard Nominal Discharge Currents, IEC clause 41); terminals, 2.10; discharge indicator, 2.15, and counter, 2.16; lightning, 2.18; lightning surge, 2.19; wave, 2.20; surge, 2.21; oscillatory surge, 2.23; time to impulse sparkover, 2.30;



(Left) Clause 33 of the IEC Standard defines wave front duration as "1.67 times the time taken by the voltage to increase from 30% to 90% of its peak value." Since *ABC* and *OED* are similar triangles and since *BC* is 0.6 of *ED*, then *OE* is *AB*/0.6 or 1.67 *AB*. Duration of wave front is time from virtual zero to time when virtual zero line intersects the wave crest ordinate

(Right) Clause 33 defines current wave front duration as "1.25 times the time taken by the current to increase from 10% to 90% of its peak value." Basically the meaning is the same as in the case of the voltage wave, Fig. 1, except that the points defining the line which determines the virtual zero are 10% and 90%. Thus, the duration is 1.25 times the time *AB*.

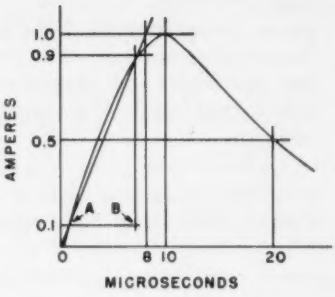


Fig. 1. IEC definition of voltage wave shape.

Fig. 2. IEC definition of current wave shape.

impulse sparkover volt–time characteristic, 2.31; disruptive discharge, 2.32; flashover, 2.33; sparkover, 2.34; power frequency withstand voltage, 2.35; impulse withstand voltage, 2.36; basic impulse insulation level (BIL), 2.37; insulation class, 2.38; circuit voltage, 2.39; nominal voltage, 2.40; fault current, 2.41; recovery voltage, 2.42; rating, 2.44; discharge voltage current characteristic, 2.51; discharge withstand current, 2.53; unit operation, 2.55.

Some definitions in the IEC Standard do not appear in ASA. These are: non-linear series resistor, IEC clause 5; prorated unit of an arrester, C1.7; rated frequency of an arrester, C1.9; nominal discharge current, C1.11; coefficient of earthing, C1.17; isolated neutral system, C1.18; resonant earthed system, C1.19; sampling tests, C1.23; rectangular impulse, C1.26; full-wave voltage impulse, C1.30; chopped-wave voltage impulse, C1.31; virtual duration of wave front, C1.33 (included in ASA 2.27); time to half value on the wave tail, C1.35 (included in ASA 2.27); wave shape designation of an impulse, C1.36 (included in ASA 2.27); virtual duration of a rectangular wave, C1.37.

The more important differences which appear to exist between the ASA and the IEC definitions are discussed in the following paragraphs.

The IEC recommendation contains a definition of a ratio called the "coefficient of earthing of a 3-phase system." This is defined as "The ratio of the highest rms voltage to earth of the sound phase or phases at the point of application of an arrester during a line to earth fault, (irrespective of the fault location) to the highest line to line rms voltage, expressed as the percentage of the latter voltage." This is a precise way of expressing the maximum power-frequency voltage that can occur across the arrester terminals, which is also another way of stating the minimum permissible arrester voltage rating.

In the ASA Standard the usual practice is followed of defining an "effectively grounded neutral system" as one where the highest phase-to-earth voltage does not exceed 80% of the highest phase-to-phase voltage. While the "effectively grounded" concept has been widely used in the arrester application work by applying the "80% rule" to everyday problems, the IEC method simplifies the expression of all degrees of earthing. In the IEC recommendations, an earthed neutral system is defined on the basis of this coefficient of earthing. The coefficient of earthing is then used in the IEC "Guide to the Selection of Arrester Voltage Rating" (clause 57) to describe the several types of systems. The term coefficient of earthing or grounding is not yet used in U. S. Standards. At the present time, a restatement of the definition for the coefficient of earthing is being considered (by interested groups in the United States), with the expectation that the definition will be adopted by all national committees for use in their own standards.

An apparent striking difference is in the definitions pertaining to wave shapes, principally in the duration of the wave front. In ASA it is defined for both voltage and current as the time from the virtual zero to the actual crest of the wave. In the IEC Standards it is defined as illustrated in Figs. 1 and 2. Offhand it might appear that the IEC and ASA Standard test waves differ; see Table III. Actually there is no significant difference; it is merely a matter of definition.

Table III. Comparison of Test Waves, Measured in Microseconds

Type of Wave	IEC	ASA
Voltage	1x50	1.5x40
Current	8x20	10x20
Current	4x10	5x10

Consideration of the voltage wave, Fig. 1, indicates that the IEC and ASA waves are actually almost alike, and if the tolerances are taken into account, they fall in the same class. A compromise on a wave with a front of 1.2 microseconds, defined by the IEC method, is under discussion.

The IEC and ASA current waves are actually identical. For example, the IEC wave front designated by the IEC definition as 8 microseconds reaches its actual crest in 10 microseconds. The IEC method of designating the wave front has merit because the point arbitrarily chosen to define the time to crest is more sharply defined than the actual crest in which the wave form is quite flat, making it more difficult to select a precise point of crest. The IEC method of

defining the wave front is under discussion for adoption in the ASA with corresponding changes in the designations of the standard test waves. This involves no change in United States testing practices.

Classifications and Ratings. In the United States and Canada, it is the practice to classify lightning arresters as station, intermediate, distribution, and secondary types. While the names are fairly descriptive of the general usage of these arresters, the classification also serves to designate a difference in quality, with the quality difference being brought out by the testing requirements. On the other hand, in the IEC Recommendation, the classification is essentially the same but is designated in terms of amperes rather than by names. This is shown in Table IV. The IEC 2,500-ampere class distribution arrester, of which there is no United States counterpart, is intended as a low-cost arrester for use on rural distribution lines. There seems little likelihood that this lesser quality distribution arrester will find favor in American practice, as experience has been that distribution systems expose lightning arresters to severe conditions and high-quality devices are required for survival.

Table IV. Classification of Arresters

ASA	IEC*
Station	10,000-ampere
Intermediate	5,000-ampere, Series A
Distribution	5,000-ampere, Series B
None	2,500-ampere
Secondary	1,500-ampere

* The ampere value is the 8x20-microsecond current wave used in the duty-cycle test.

Testing Specifications. When ASA initially prepared to take part in the preparation of an international standard, it was recognized that there were a number of differences to be reconciled before agreement could be obtained among the several national committees involved. One by one, however, these differences were resolved to produce a testing standard essentially as severe and, in one notable instance, more severe than the American Standard. This more severe requirement was the one pertaining to the power-frequency voltage that must be held across the test specimen during the duty-cycle test. Under American practice, the voltage was allowed to drop to 90% of the name-plate rating of the arrester. In the IEC Recommendations, the voltage must be maintained at 100% of rating and is allowed to rise to not more than 110% of rating on interruption of the power follow current. Inasmuch as the U.S. National Committee concurred in this more severe duty-cycle test, the same requirement was incorporated in the ASA Arrester Standard then undergoing revision.

The difference between the practices in the United States and Europe on the question of wet tests, which will require more time to reconcile, was taken care of by establishing a Series I test conforming to European practice and a Series II test conforming to practice in the United States and Canada. Series I tests require that the rate of precipitation shall be equivalent to 3.0 mm (0.12 inch) per minute and that the resistivity of the water shall be between 9,000 and 11,000 ohm-centimeters (3,500 and 4,300 ohms per inch cube). Series II tests require a rate of precipitation equivalent to 0.2 inch (5.08 mm) per minute and a water resistivity of 7,000 ohms per inch cube (17,800 ohm-centimeters) ±15%. The Recommendation suggests that each national committee use only one of these practices. It is also noted that the consolidation of the two practices into one is under consideration by IEC Technical Committee 42.

It will be recalled from Table IV that the IEC Recommendation lists two 5,000-ampere arresters: Series A and Series B. This division was necessary to accommodate the difference in performance characteristics in required tests for the two categories shown. Series A (intermediate) arresters are based on performance characteristics in practice in all countries. Series B (distribution) arresters are based on performance characteristics in practice in United States and Canada. Again, it is recommended that each national committee indicate which series is selected for tests.

Some other differences between the ASA and IEC documents are brought out in Table V, which lists the major test requirements for station arresters. Certain differences will be noted for the front-of-wave sparkover tests. While the rate of voltage rise under the two standards is essentially the same for a given arrester rating, the IEC requires that the sparkover be below a specified maximum where, according to United States practices, the sparkover is left as an unspecified

Table V. Major Test Requirements for Station Arresters

Test	ASA	IEC
1. Front-of-wave sparkover	Rate of rise specified. No sparkover value specified	Rate of rise and maximum sparkover specified*
2. 1x50 sparkover	Not required	Maximum value specified†
3. Duty cycle	10 kiloamperes (10x20),‡ 20 operations	10 kiloamperes (8x20),‡ 20 operations
4. Insulation withstand		
Dry	One minute, selected value	One minute, selected value
Wet	10 seconds at about 80% to 90% dry value	One minute, same value as dry test
5. Long duration wave	150 amperes for 2,000 microseconds	150 amperes for 2,000 microseconds
6. High current	100 kiloamperes (5x10)‡	100 kiloamperes (4x10)‡

*From IEC clause 50: ". . . . Not less than ten positive and ten negative impulses shall be applied to the arrester . . . On none of the impulses shall the sparkover voltage exceed the value given in the appropriate column of Table III with no plus tolerance allowable."

†From IEC clause 49: ". . . . Ten positive and ten negative impulses having an amplitude given in the appropriate column of Table III shall be applied to the arrester and the series gap of the arrester shall sparkover on every impulse. If in either series the gaps fail to sparkover once only, an additional ten impulses of the same polarity shall be applied and the gaps must spark over on all of these impulses."

‡The numbers are different for the same wave due to a difference in ASA and IEC definitions.

quality factor. It also will be noted that the IEC Recommendation requires what is called a 1x50-microsecond sparkover test. It should be pointed out that in no way is this test to be considered a critical sparkover test as was written in the American Standard in times past. The IEC test requires that the arrester spark when the specified test wave is applied to demonstate that a full 1/50 wave of the amplitude called for cannot appear at the arrester. The footnotes of Table V state more fully the requirements for both the front of wave and the 1x50-microsecond sparkover test. It also will be noted under the duty-cycle and high-current tests that the wave shape numbers are different. It will be recalled in the discussion of wave shape definitions, that the actual shape of the 10x20 wave by ASA definition is exactly the same as an 8x20 wave by IEC definition. All in all, Table V indicates that the requirements in the two standards are essentially of equal severity.

The IEC Recommendation specifies a minimum routine test, whereas ASA leaves such tests to the discretion of the manufacturer. In acceptance tests IEC requires the 1/50 sparkover test while ASA calls for the front-of-wave test.

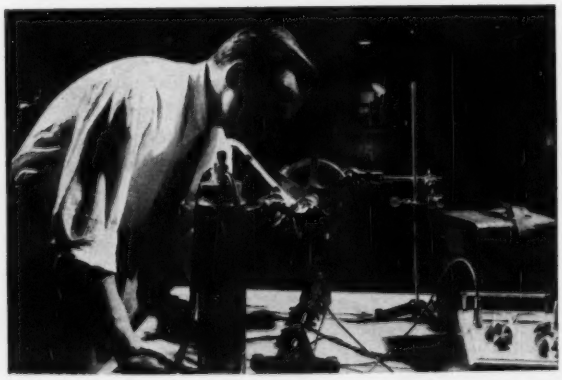
Applications. Practices in ASA and IEC differ on the question of application material in a standard. It is common practice in the IEC to include all application material in addition to testing and manufacturing standards so as to have all information in one document. Generally it is ASA practice to restrict a Standard to the standardized material on testing and manufacturing, leaving the application data to be developed and published by the Apparatus Committee concerned or by ASA as a separate document. It seems rather logical that certain basic application data, such as data which are fundamentally characteristic of circuits and of circuits protected by lightning arresters, might well be made a part of the Standard, in order to reduce the number of sources where information may be found. In an appendix to the IEC Recommendation will be found a diagram and discussion of a typical testing circuit suitable for making duty-cycle tests on lightning arresters. The purpose of this appendix is to give guidance to those who have experienced difficulty in their laboratories in obtaining the required data. This diagram should not be construed to mean that it is the only circuit which will yield uniformity of results. Because of this, it is the belief that definite testing circuits and laboratory practices for the testing of lightning arresters have no place in an American standard any more than performance characteristics such as impulse sparkover.

Revisions of Standards. It is the intent in IEC, just as it is in ASA, to maintain the Lightning Arrester Standard up to date by revising individual clauses rather than to let the whole standard become so out of date that total revision would be necessary. It is intended that revisions will be proposed and approved paragraph by paragraph as new developments make such revisions necessary. With IEC meeting annually, revisions can be presented, formulated by the Secretariat, circulated for comment, and then discussed in committee until a final meeting of the minds can be accomplished.

At the IEC meeting 2 years ago when the Recommendation on valve arresters was duly approved, suggestions were made for certain revisions. Some of these are as follows: cantilever strength; extra-high-voltage arrester characteristics; long wave test; relation of the long wave severity to the duty-cycle test; relation of the long wave to the switching of cables and capacitors; and a revision of the preferred voltage ratings. None of these revisions, however, will be acted on immediately. Technical Committee 37 has before it at the present time Part II of the arrester Recommendation which deals with expulsion-type lightning arresters. It is anticipated that Part II will be completed for final approval soon. National Committees have been requested to submit proposals for a revision of Part I, Valve Arresters.

SUMMARY

IT MAY BE CONCLUDED that the IEC Recommendation and the ASA Standard for valve-type lightning arresters contain essentially the same provisions. The IEC Recommendation, however, specifies maximum arrester protective levels and differs in other minor respects from the ASA Standard. Recognizing that the major issues have been resolved, and that the controversial provisions, in all probability, could also be resolved in future discussions, the U. S. National Committee joined with 21 other national committees in voting unanimous approval of the valve arrester Recommendation. As a result, one more step has been taken toward the international standardization of all products offered in world trade.



SPACE DETECTIVES — Scientists at Sperry Gyroscope Company can conduct exacting studies of infrared radiation behavior in atmospheres vastly different from that of the earth. In special test facilities within this 86-foot-long tunnel, blackened walls aid in controlling background radiation. Engineer in foreground measures efficiency in an infrared detection device as his colleague adjusts "black body," which emits controlled amounts of invisible infrared light. Unlike radar, these systems generate no energy of their own and, thus, can operate in secrecy.

Electromagnetic Unbalance of Transmission Lines

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A SIMPLE but satisfactorily approximate method of computing electromagnetic unbalances[1] for double circuit lines, either with or without ground wires, results if the following simplifying assumptions are made:

1. The two circuits are symmetrically arranged on the transmission tower.
2. Line currents in each of the two circuits are balanced and equal.
3. External impedances Z_{ext} terminating the lines are balanced.
4. Mutual impedances are small compared to self-impedances, and voltages induced through mutual impedance by small (negative- or zero-sequence) currents are negligible.

The unbalance equations may then be solved for the negative- and zero-sequence currents in terms of the balanced load current:

$$I_2 = \frac{I_1(Z_{21} + Z_2'_1 + Z_{21'} + Z_2'_1')}{2(Z_{22} + 2Z_{2ext})}$$

$$I_0 = \frac{I_1(Z_{01} + Z_0'_1 + Z_{01'} + Z_0'_1')}{2(Z_{00} + Z_{00'} + 2Z_{0ext})}$$

The primed quantities in the mutual sequence impedance subscripts refer to the second circuit. Thus, Z_{21}' is the mutual impedance of the negative sequence in the first circuit due to positive sequence current in the second circuit.

The mutual impedances are affected by ground wires and by the phase rotation. For 36 possible arrangements of the two 3-phase circuits on a tower, there are 18 independent sets of values of Z_{21}, $Z_2'_1$, Z_{01}', and $Z_0'_1$; and 6 independent sets of values of Z_{01}, $Z_0'_1'$, Z_{21}, and $Z_2'_1'$. One ground wire introduces an extra term to the expression for each mutual impedance. These extra terms can be factored into combinations of only three independent terms. For Z_{21}, Z_{21}', $Z_2'_1$, and $Z_2'_1'$, the correction terms will be equal in magnitude, but different in phase relation. The same applies to Z_{01}, Z_{01}', $Z_0'_1$, and $Z_0'_1'$. Two ground wires have similar effects, but add more complicated correction terms.

Thus, the mutual impedances can be evaluated by first computing the mutual sequence impedance without ground wires, and then adding the correction term vectorially.

The phase rotations on the tower govern the magnitude of the resultant unbalance current. Minimum electromagnetic unbalance is obtained when the successive voltage peaks in the two circuits occur in conductors as far apart as possible. If the phase sequences are *a-b-c* and *d-e-f*, six equivalent optimum arrangements result for the hexagonal array:

$$\begin{matrix} a\ f & & c\ e & & b\ d & & c\ d & & b\ f & & a\ e \\ b & e, & a & d, & c & f, & b & e, & a & d, & c & f \\ c\ d & & b\ f & & a\ e & & a\ f & & c\ e & & b\ d \end{matrix}$$

For the delta array, these are the optimum arrangements:

$$\begin{matrix} a & f & c & e & b & d & c & d & b & f & a & e \\ b\ c & d\ e, & a\ b & f\ d, & c\ a & e\ f & b\ a & f\ c, & a\ c & e\ d, & c\ b & d\ f. \end{matrix}$$

Maximum unbalances occur in the hexagonal-type array when two conductors of one circuit are inverted.

Table I. Typical Sequence Impedances and Unbalance Currents

For sequence $\begin{matrix} a & f \\ b & e \\ c & d \end{matrix}$, giving minimum electromagnetic unbalance

Sequence Impedance	No Ground Wire	One Ground Wire	Two Ground Wires
	(ohms per hundred miles)		
Z_{22}	12.88 + *j* 79.3	12.92 + *j* 79.2	12.96 + *j* 79.3
Z_2	4.29 + *j* 2.47	4.31 + *j* 2.44	4.34 + *j* 2.40
$Z_{2'1}$	4.30 + *j* 2.47	4.29 + *j* 2.44	4.16 + *j* 2.39
Z_{01}	2.15 − *j* 1.24	2.59 − *j* 1.69	3.02 − *j* 2.24
$Z_{0'1}$	2.15 − *j* 1.24	1.89 − *j* 0.66	1.68 − *j* 0.027
$Z_{00} + Z_{00}$	70.1 + *j* 401.1	87.73 + *j* 387.9	103.63 + *j* 372.5
$Z_{21'}$	−2.86 − *j* 1.65	−2.87 − *j* 1.62	−2.88 − *j* 1.58
Z_{01}	−1.05 + *j* 0.61	−1.302 + *j* 1.19	−1.57 + *j* 1.52
$Z_{0'1}$	−1.05 + *j* 0.61	−0.61 + *j* 0.16	−0.20 − *j* 0.38
I_1, amperes	627.55 / 0°	627.55 / 0°	627.55 / 0°
I_2, amperes	3.57 /122.4°	3.56 /122.5°	3.46 /123.4°
I_0, amperes	1.61 / 68.3°	1.80 / 79.4°	2.08 / 82.8°

The calculated unbalance currents for a typical hexagonal-array 230-kv double-circuit line, 100 miles long, feeding an inductive 250-mva load, are given in Table I for the minimum electromagnetic unbalance configuration. For the maximum electromagnetic unbalance arrangement with the same spacing and two ground wires, I_2 is 5.15 amperes and I_0 is 17.2 amperes.

The unbalance impedances which were calculated by the approximate method and shown in Table I have been checked using a large digital computer; the results agree within 1%.

Digest of paper 59-808, "Electromagnetic Unbalance of Untransposed Transmission Lines—Part III. Double Circuit Lines," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959. Published in AIEE *Power Apparatus and Systems*, Dec. 1959, pp. 1362-71.

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REFERENCE

1. Unbalances of Untransposed Overhead Lines, Eric T. B. Gross. *Journal*, Franklin Institute, Philadelphia, Pa., vol. 254, 1952, pp. 487-97.

Epoxy Resin–Orlon Terminations for 4-Kv Service

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SOLID-TYPE paper-insulated cables with lead sheaths are generally used for underground power distribution. Because of the hygroscopic nature of paper, these cables normally are terminated with porcelain potheads. Potheads are, however, relatively expensive, and attempts have been made to eliminate them, particularly on circuits operating in the 4-kv range.

The Baltimore Gas and Electric Company has been investigating the use of epoxy resins and has developed formulations suitable for cable accessories, particularly in combination with orlon tape. The epoxy resin–orlon construction has high dielectric strength, strong adherence to metals, and moisture and oil imperviousness.[1]

Fig. 1 illustrates the application of epoxy resin impregnated orlon tape on paper-insulated cable. The cable end is wrapped from the lead sheath, over the cable insulation, compression-type connector, and over about 1 inch of the jacketed overhead wire.

The resin may include fillers to improve its properties for outdoor applications. Alumina hydrate has been found useful for this purpose.[2,3] When a particularly smooth outer surface is desired, a filled epoxy resin coating material of special composition may be used. The orlon tape is saturated with the resin on the inside by brushing as the tape is applied. The resin is then forced through the tape as it is pulled tight.

To determine the electrical adequacy of this design, sample terminations were successfully subjected to the dielectric design tests specified in the AIEE *Standard for Potheads, No. 48*.[4] The impulse tests were continued beyond the required 75 kv BIL and breakdowns occurred at 110 kv for specimens with 6.5-inch creepage distance (external flashover) and at 125 kv for specimens with 10-inch creepage distance (cable failure).

Tests of the strength of the bond between the resin and copper and lead have been described previously.[1] Further tests were made by cycling current through 500 MCM PILC (paper-insulated lead-covered) cable with similar resin terminations on each end. Forty-two heating cycles were applied, generally with the current on for 16 hours and off for 8. The cycling current was increased from 400 amperes to 1,100, the latter being more than double that which would be applied to the cable under emergency loading conditions in the winter. A small oil seepage appeared during the fourth cycle at 1,100 amperes.

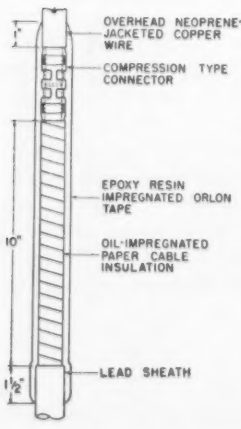

Fig. 1. A 4-kv epoxy resin–orlon cable termination.

Service installations have already withstood the extremes of summer and winter weather. To obtain additional data on weathering, 22 resin terminations with various modifications are now under an accelerated test at a location where the atmosphere is fairly heavily contaminated with industrial fumes. This test at twice normal operating voltage will be continued for a year or more. Along with the resin terminations, there are standard porcelain terminations and rubber cable terminations to afford a basis for comparison.

The epoxy resin–orlon 4-kv termination is now standard for use indoors in the Baltimore Gas and Electric Company system and is used at selected locations out of doors. Insufficient data on weathering qualities and problems arising from long curing times in cold weather are the reasons for this present limitation. A hard cure of the epoxy resin–orlon insulation is obtained in about 2 hours at 75 F ambient temperature. At 40 to 50 F this may be 10 to 12 hours and at lower temperatures it may be necessary to apply heat to the termination.

The epoxy resin–orlon termination has resulted in cost savings through the elimination of porcelain potheads on PILC cable. It has also resulted in savings where rubber cable was formerly used for the terminal section extended from the PILC cable (to eliminate the need for a pothead) by now permitting the use of PILC cable throughout. Laboratory electrical tests, tests of the adequacy of the resin to metal seal, and tests of the resistance of the epoxy resin–orlon wrappings to moisture penetration indicate the suitability of this termination. Accelerated outdoor aging tests are in progress to provide additional data on weathering. Service experience of approximately a year has been trouble-free.

REFERENCES

1. Epoxy Resin–Orlon Cable Terminations for 33-Kv Service, P. L. Betz, O. W. Lusby, J. J. Rueckert, J. F. Foley, M. B. Gordon. AIEE *Transactions*, pt. III *(Power Apparatus and Systems)*, vol. 78, Dec. 1959, pp. 977-83.

2. Internal Oxidation Mechanism for Nontracking Organic Materials, R. S. Norman, A. A. Kessel. *Ibid.*, vol. 77, Aug. 1958, pp. 632-36.

3. P. W. Jones. *U. S. Patent no. 2,768,264*, Oct. 23, 1956.

4. Standard for Potheads (Including Test Code). AIEE *Standard No. 48*, Jan. 1948.

Digest of paper 59-660, recommended by the AIEE Insulated Conductors Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Middle Eastern District Meeting, Baltimore, Md., May 19-21, 1959. Published in AIEE *Power Apparatus and Systems*, Dec. 1959, pp. 983-86.

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Effect of Ambient Air on Transformer Temperature

M. F. BEAVERS
FELLOW AIEE

THE TEMPERATURE RISE of all self-cooled apparatus is based upon the rise above the surrounding or ambient air temperature.

If the ambient air temperature is constant or changes very, very slowly throughout the temperature test on a transformer, the air temperature as measured by thermometers (or thermocouples) suspended in the surrounding air would be entirely satisfactory as a reference temperature. In a constant ambient air temperature, and assuming no disturbing influences such as breezes, nearby objects, sunlight, etc., the temperature rise of the unit over the ambient air temperature will ultimately become constant within prescribed limits.

However, if the ambient air temperature changes suddenly during the test, the transformer temperature will not change suddenly, due to the thermal lag or thermal capacity of the large mass of materials in the transformer. The temperature rise of the unit over the air will, therefore, fluctuate with moderate changes in the ambient air temperature. This condition is not too disturbing during the heating-up part of the temperature test, but it becomes a real problem when the transformer is nearing a thermal equilibrium.

Since the temperature of a transformer under constant load does not respond immediately to sudden changes in the surrounding air temperature, it is apparent that the temperature rise of the unit over the surrounding air temperature, as measured by thermometers suspended in the air, does not correctly evaluate the effect of changing air temperature on the temperature of the transformer.

One approach to this problem would be to place two or three duplicate but unheated units in the general area of the unit under test as suggested in paragraph 5.220 of the AIEE Master Test Code for Temperature Measurement of Electric Apparatus, and use the average of the temperature of these idle units as the ambient air temperature. Even if this procedure were practical, it would not be perfect since a duplicate unheated body may not respond to air temperature changes in exactly the same manner as a heated body.

An alternative to using duplicate units as devices for determining the ambient air temperature would be to use some relatively small device which is affected by ambient temperature changes to about the same extent as the heated unit is affected.

The use of such device is recommended in the American Standard Test Code for Transformers, but no suggestion is given in this test code concerning the general construction and size of such containers which will have a certain time constant. Furthermore, since all transformers do not have the same thermal time constant, and, therefore, do not respond to ambient temperature changes to the same extent, it is desirable to use a thermometer container having a time constant which closely approximates that of the transformer under test.

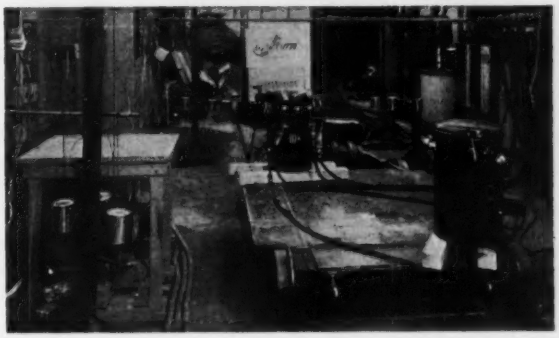

Fig. 1. Test arrangement of 10-kva transformers and ambient reference temperature devices.

Tests on several types of thermometer containers demonstrate that a considerable latitude in time constants can be obtained by using various combinations of factors such as type and quantity of liquid, container material, condition of external surface (painted or unpainted), and whether the container is open or closed.

Accumulated data illustrate that if the time constant of such a container is correctly chosen, fluctuations in ambient temperature will not materially affect the temperature rise results of a transformer during thermal tests.

Fig. 1. shows a typical test arrangement in a draft-free heat-run test room wherein one transformer is loaded and a duplicate unit acts as an idle or ambient reference temperature device. Thermometer containers are located in three different positions around the loaded transformer to determine the average ambient air temperature of the area.

Test results indicate that a commonly available quart-size metal can (unpainted), with cover, has a range in time constant of approximately 1 hour to 3 hours, depending upon the amount of water in the can. The time constant may be increased to about 4 hours by enclosing the can in an insulating sleeve. On the other hand, a time constant of the order of 30 minutes can be obtained with a partially filled pint-size metal can with outside surface painted.

Digest of paper 59-664, "Measurement of Ambient Air Temperature During Temperature Test on Transformers," recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Middle Eastern District Meeting, Baltimore, Md., May 19-21, 1959. Published in AIEE *Transactions*, pt. III (*Power Apparatus and Systems*), vol. 78, Dec. 1959, pp. 1,021-29.

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A Small High-Speed Transistor and Ferrite Core Memory System

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The design and operation of a 400-bit memory system for use in a time-division electronic switching system.

MEMORY for computer-type systems has received extensive study and design effort in the past few years. This effort has been directed mainly at producing faster, larger, and less expensive systems in the thousand-to-mega-bit sizes. However, other important applications of memory systems are being investigated.

DESIGN OBJECTIVE

THE PRINCIPAL OBJECTIVE was to obtain as short a read-write time as possible under the following operating conditions:

Temperature—This memory was to be a part of a small system, used in a variety of locations; therefore, temperature control was not practical. Operation over an equipment temperature range of 30 to 140 F was required.

Simplicity and Consequently Cost—In a small memory system the access circuitry accounts for the largest part of the cost. Therefore, simplicity in access circuits was desirable.

Solid-State Devices—In the interest of small system size and good reliability, it was decided to use only solid-state components—transistors, diodes, and ferrite memory elements.

CHOICE OF MEMORY ELEMENT

BESIDES THE FERRITE CORE, there are a number of memory devices, such as the twistor, in various stages of research or development which offer promise of high speeds. However, for this system the ferrite core was selected because of its present wide acceptance as a reliable device. The General Ceramics *S4-F394* core was chosen from the many commercially available cores with like characteristics and switching times in the 2-microsecond (μsec) range.

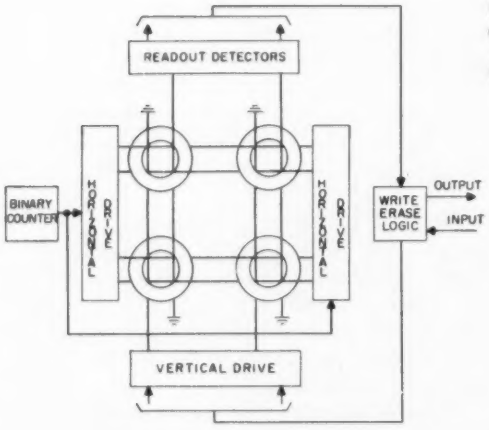

Fig. 1. Block diagram of memory systems.

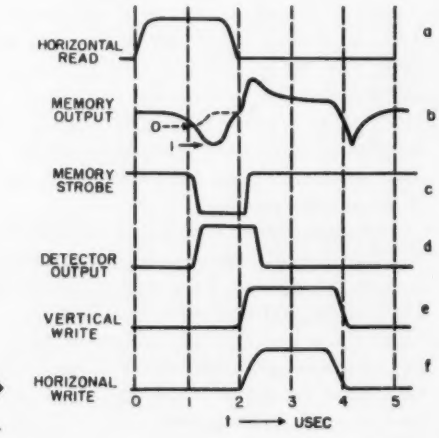

Fig. 2. Memory timing.

GENERAL SYSTEMS BLOCK DIAGRAM

A BLOCK DIAGRAM of the over-all system is shown in Fig. 1. The information in each row of the core array is read and written back in time sequence. The read pulse from the horizontal drive circuit reads a row of cores. The signals from the 20 cores are examined by readout detectors which discriminate between a "1" and a "0." Immediately following, a write pulse is delivered to the same row. Prior to the write pulse the system has received information as to whether the same or different information is to be written into the memory. The write-erase logic then causes the ap-

Essentially full text of paper 59-826, recommended by the AIEE Communication Switching Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959. Published in AIEE *Transactions*, pt. I (*Communication and Electronics*), vol. 78, Jan. 1960, pp. 763-69.

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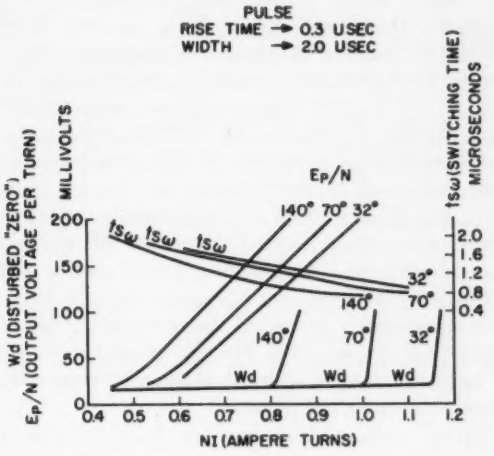

Fig 3. Memory core characteristics (General Ceramics S4-F394).

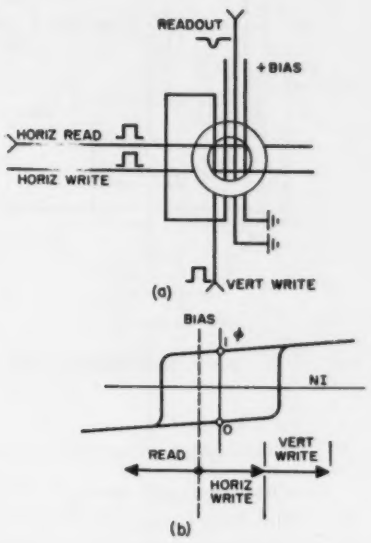

Fig. 4. Memory core connections.

propriate vertical drive circuits to produce write pulses. The coincidence of the horizontal and vertical pulses causes the selected cores to switch, thus writing the information. During the next time slot the adjacent row of cores, i.e., the next word, is subjected to the same operation. This process of reading and rewriting each word (or writing a new word) continues in a sequential fashion until all 20 words have been processed. The cycle is then repeated. The sequential operation of the memory is controlled by the binary counter which delivers 20 binary words to the horizontal drive and then recycles. The horizontal drive circuitry acts as a stepping switch, sequentially selecting 1 out of the 20 rows in the memory.

The read-write operation for each word requires 5 μsec, as shown in Fig. 2. This 5-μsec time slot is divided into the read and write phase by means of timing pulses from an external clock. The cycle time for processing all 20 words is 100 μsec.

MEMORY CORE

THE MEMORY CORE CHARACTERISTICS place requirements on the access circuitry as well as determining, to a large degree, the system's operating margins. Twenty-five *S4* cores were measured and the resulting data are shown in Fig. 3. These data represent the limiting characteristics. For example, the switching time curves show the slowest core switching time for each of the conditions of temperature and drive. The output voltage represents the lowest output voltage for a "1" from any of the 25 cores. The walkdown (W_d) curve represents the highest read voltage from any core after a series of half-write pulses.

The W_d curves as plotted were obtained by using half the pulse current as that reported on the abscissa. Thus, for example, W_d, for a full write current of 800 ma (milliamperes) is measured with 400 ma. This is similar to actual system operation.

From Fig. 3 the unbiased operating limits can be determined. The drive current limits are determined by three points:

1. The maximum amplitude of a series of half-write pulses at 140 F which will not cause switching of an unselected core. This current is found to be 400 ma.
2. The minimum amplitude of a full-write pulse which will just switch the core at 32 F—which is 660 ma.
3. The minimum amplitude of read pulse which will provide a satisfactory output signal—as determined from the curves—is 780 ma.

With no bias the pulse current limits are: (a) read—minimum 780 ma and (b) one-half write—minimum 330 ma, maximum 400 ma.

Biased operation of the memory offers several advantages. When coincidence current is used only for writing, bias in the read direction offers the following advantages:

A greater variation in the half-write current is permissible.

Reduction in read current is possible.

Setting the bias at 300 ma, the pulse current amplitudes are as follows:

The minimum amplitude of read is 480 ma.

The one-half write is between a minimum of 480 ma and a maximum of 700 ma.

MEMORY ARRAY WIRING

D-C BIAS AND CURRENT PULSES applied to the memory are determined by the wiring for the array which is shown in Fig. 4 (a). The horizontal wires are the read and the horizontal half write. Four vertical wires are provided; one for bias, one for the readout signal, and two for a double-turn vertical half-write pulse. A hysteresis loop of a core is shown in Fig. 4 (b). The bias is in the read direction such that nominal-read horizontal-write and vertical-write drives are approximately equal amplitude.

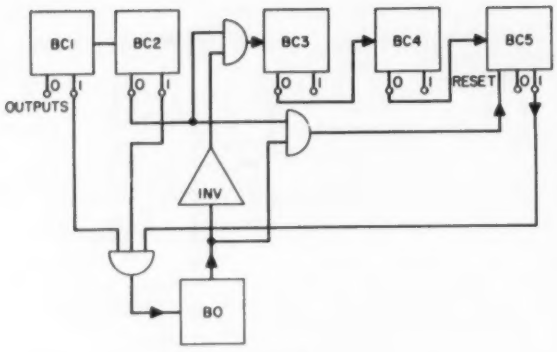

Fig. 5. Block diagram of binary counter.

HORIZONTAL DRIVE AND BINARY COUNTER

Two basic building blocks are used to make up the horizontal drive circuits. A 5-stage binary counter cycling from 0 to 19 establishes the means of sequential access to the 20 rows of the memory. Transistor-diode logic is then employed to instrument a binary to 1-out-of-20 translator. Distributed among the 20 rows are a total of 40 high-current pulses, 20 read and 20 half-write. The 5-stage binary counter's normal cycle of 32 is shortened to 20 by an additional advance circuit. A block diagram of the counter is shown in Fig. 5. The binary counter stages are of special design to provide a good output waveform. A circuit diagram is shown in Fig. 6. Diodes connected between the transistor's collector and the cross-coupling capacitor provide isolation which permits an output waveform determined largely by the transistor characteristics and not by other circuit elements. Also, diodes have been connected between base and collector terminals of the transistors to limit the degree to which high-β units will go into saturation. Rise and fall times of the counter stages average about 0.1 μsec and 0.7 μsec, respectively. The longest advance time, when all stages are switching, is approximately 1 μsec. Since the transistors employed in the counter are of the medium power variety, they are capable of 200-ma output pulse current, which minimizes the number of subsequent amplifiers.

The horizontal drive circuits are shown in block form in Fig. 7. The first two binary counter stages operate in conjunction with a binary to 1-out-of-4 translator to operate transistor switches on one side of the memory. On the other side of the memory, the five transistor switches are operated from the remaining three binary counter stages and a 1-out-of-5 translator. Thus, the 1-out-of-20 selection is accomplished in a matrix with two 1-out-of-4 and 1-out-of-5 translations; these are combined as shown in Fig. 8. Relative timing is also shown in the figure. Two 1-out-of-4 translations are used: one is combined with the clock read pulses and the other with the write pulses.

A typical pulse current path is shown in Fig. 9. Transistor *Q1* amplifies the clock pulse and drives four gate circuits similar to that connected to the input of *Q2*. The horizontal wire through the memory is shown in *RL*. With a positive going pulse applied to one side of the memory wire, an appropriate negative going pulse is applied to the other by a circuit such as *Q3* and *Q4*. Transistors *Q1*, *Q2*, and *Q3* are p-n-p types and *Q4* is an n-p-n type. The binary counter and *X* pulse circuits operate between ground and the positive battery while the *Y* pulse circuits operate between ground and the negative battery. Stage *Q3* provides the inversion and voltage shift necessary to connect the diode logic from the binary stages to the n-p-n transistor *Q4*.

READOUT DETECTOR

The readout detector diagram is shown in Fig. 10. It is a blocking-oscillator circuit with collector-to-base feedback. Since the minimum output from the memory for a "1" is 100 mv (millivolts) and the maximum noise

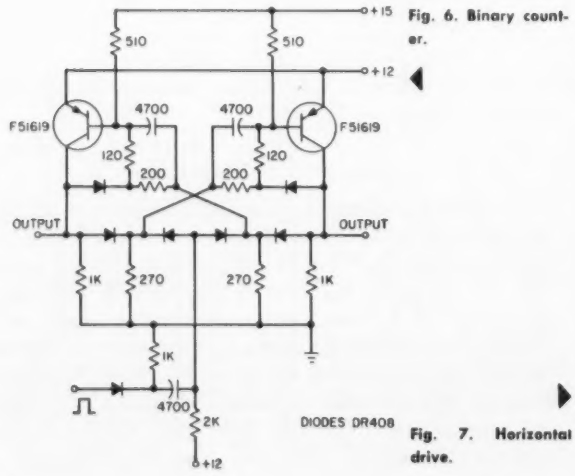

Fig. 6. Binary counter.

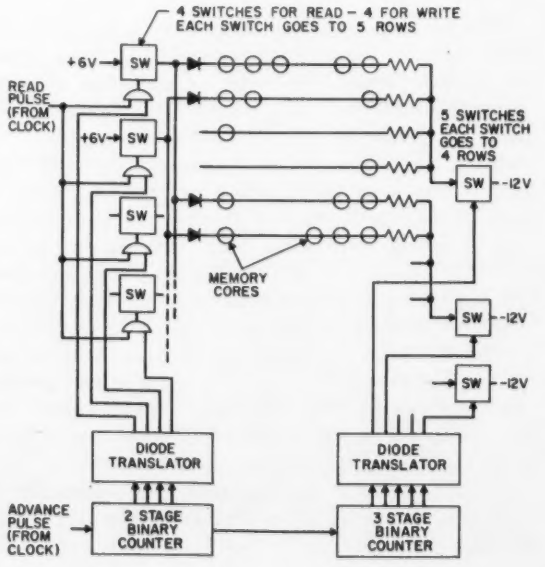

Fig. 7. Horizontal drive.

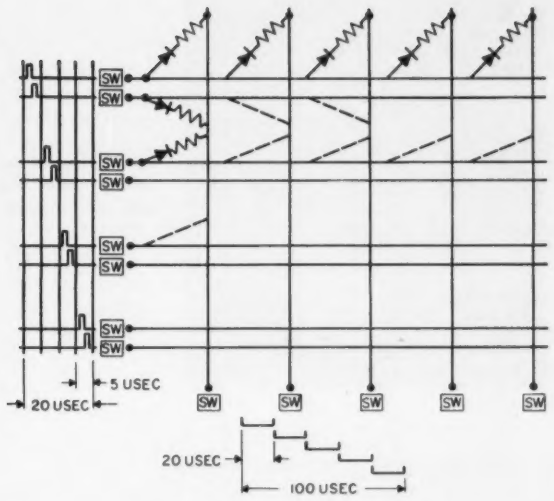

Fig. 8. Horizontal read-write timing.

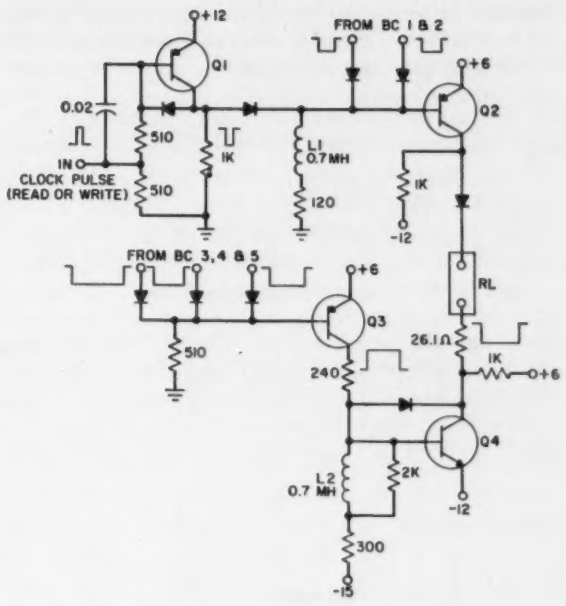

Fig. 9. Typical horizontal pulse current path.

for a "0" can be as high as 50 mv during the read interval, the detector is designed to have a threshold of 60 to 90 mv. The transistor is normally biased in the cut-off condition, and when the signal from the memory exceeds its threshold, an output is produced.

In addition to the noise produced by the shuttling of the cores during the read interval, there is also a large noise caused by the coupling from the vertical write wires. The noise from the vertical write pulse is in the form of spikes, both positive and negative. The detector circuit does not respond to positive signals but the negative spikes are in the same direction as the desired signal and about twice as large in magnitude. The negative spike occurs at the trailing edge of the write pulse just ahead of the read output. To guard against the noise, a 1 μsec interval is provided between read-write cycles and the memory output is strobed during the readout interval. Whether a "1" is present or not will be determined when the enabling gate in the detector circuit is operated. The memory strobe pulse is shown in *c* of Fig. 2. Thus, the blocking oscillator detects the wanted signal during the read period, and is disabled and insensitive to the noise signal at other times.

A second function of the detector is to produce sufficient storage of the detected signal such that its output overlaps the write interval and the information can be recirculated. This storage is obtained by extending the detector pulse width beyond the read period as shown in *d* of Fig. 2.

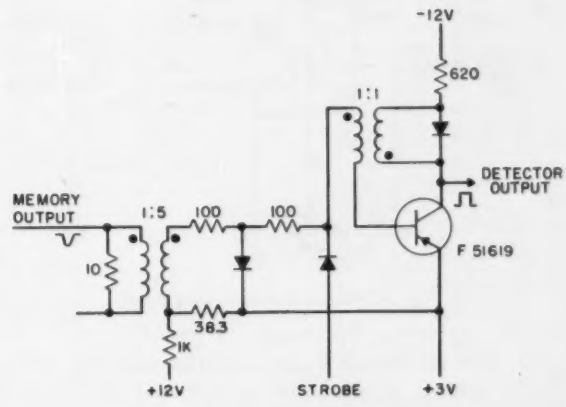

Fig. 10. Readout detector.

WRITE AND ERASE LOGIC GATES

WRITING NEW INFORMATION and erasing the old is performed with the write and erase logic gates. The circuit is shown in Fig. 11. The gates are the connecting links between the readout detector and the vertical drive circuit. When a write pulse appears at the input

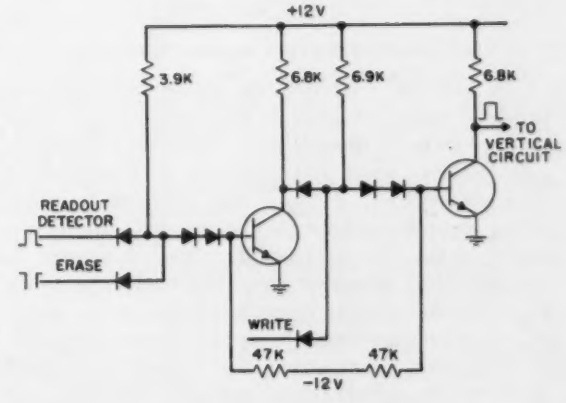

Fig. 11. Write and erase gates.

of the write logic gate, an output is produced by the vertical drive circuit. When the information is read, it is rewritten if there is no erase pulse present. The write logic gate has two inputs—the output of the erase gate, and an external write pulse.

VERTICAL DRIVE

COINCIDENCE of the vertical write current with the horizontal write current is assured by letting a clock pulse determine the timing. The circuit is shown in Fig. 12. The first stage is similar to the readout detector circuit in that it uses a blocking oscillator. The output from the logic gate begins during the read interval and lasts into the write interval. However, the blocking oscillator is kept cut off by the negative potential during the absence of the vertical gating pulse. The vertical gating pulse, which is positive, allows an output from the logic gate to trigger the blocking oscillator. The

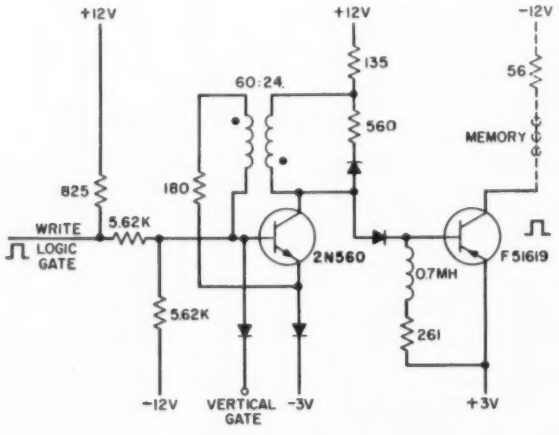

Fig. 12. Vertical half-write drive circuit.

transistor will stay in the ON condition until the gating pulse returns to the negative potential. Thus, in a manner similar to the readout detector, the vertical output pulse width is controlled by the gating pulse. The second vertical write stage is a transistor switch that provides 270 ma for driving the memory.

OVER-ALL OPERATING CHARACTERISTICS

THE LIMITING CONDITIONS associated with read and write determine the range of successful memory operation. To establish the tolerances of the system, limiting pulse position, width and amplitude were determined. Since the clock was designed with sufficient flexibility, timing and pulse width could be adjusted, making easy testing of the memory possible. These items were investigated: (1) minimum horizontal read pulse width, (2) minimum readout detector strobing pulse width, (3) minimum coincidence between horizontal and vertical write pulse, (4) minimum read-write time, (5) maximum supply voltage variation, and (6) high- and low-temperature operation.

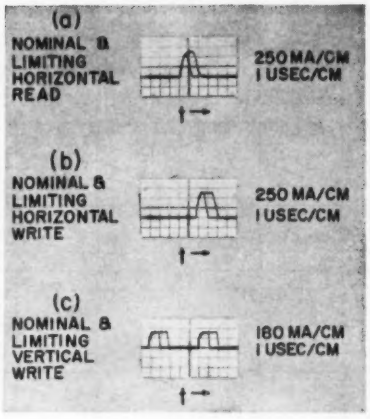

Fig. 13. Nominal and limiting read and write current pulses.

The following results were obtained:

1. *Read pulse* — Photographs of actual waveforms showing the timing of the various pulses both limiting and nominal, are shown in Fig. 13. The nominal read pulse is 600-ma peak current with rise and fall time of 0.4 μsec. The pulse width at the base is 2 μsec. Keeping other pulses at their nominal value, the read pulse width was decreased. The limiting condition in which the readout detector can no longer detect the signal was when the read current looked like a half sine wave with the base width of 1.2 μsec and the peak current of 500 ma as shown in Fig. 13 (a). It appeared that a 600-ma 2-μsec read pulse had sufficient margin to guard against circuit variations.

2. *Readout Detector Strobing Pulse* — The strobe pulse samples the memory output during the read interval. It can be made as small as 0.3 μsec in width occuring at the peak of the memory output for any one particular core in the memory. The strobe pulse is common to all detector circuits. Since the memory outputs vary from core to core not only in magnitude but also in wave shape, the strobe pulse must be at least 1 μsec wide in order to sample all the memory outputs.

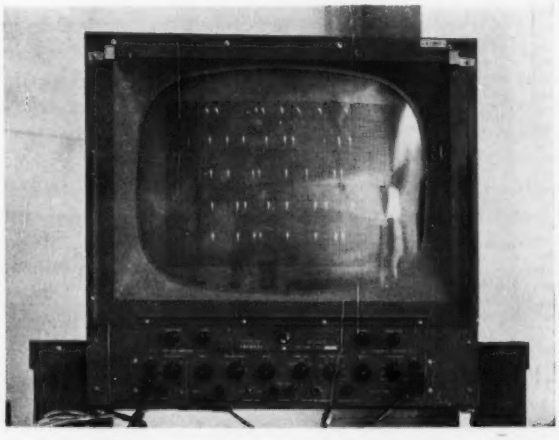

Fig. 14. Visual display of memory contents.

3. *Coincidence of Horizontal and Vertical Write Currents*—The results show that the coincidence between horizontal and vertical write current pulses is not as critical as was expected. Their nominal pulse width, across the base, is 2.6 μsec as shown in Fig. 13 (b and c). The vertical pulse was then set 0.7 μsec earlier and the horizontal pulse 0.7 μsec later than the nominal timing, and the memory performed satisfactorily. With coincidence of both vertical and horizontal write pulses the limiting pulse width was 1.2 μsec as shown in Fig. 13 (b) and Fig. 13 (c).

4. *Read-Write Time*—The aforementioned information indicates that as far as the memory element is concerned the read-write time can be decreased to approximately 2.4 μsec. However, the outputs from the access circuitry vary from circuit to circuit such that 3 μsec is about the shortest possible read-write time that appears to be obtainable at room temperature. The present system was speeded up reducing the time slot from 5 μsec to 4 μsec to provide an indication of the margin. Time constants in the binary counters were chosen on the basis of 5-μsec time slot so that speeding up the clock beyond a 4-μsec interval was not possible. However, operating with a 4-μsec time slot verifies the expected margin in the system.

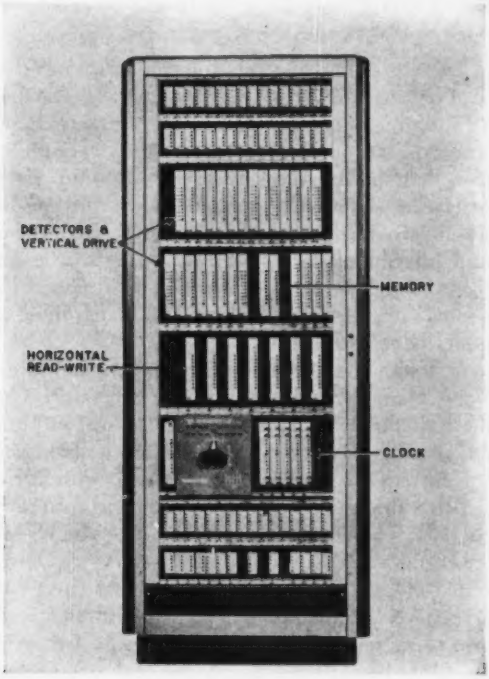

Fig. 15. Memory system.

5. *Voltage Tolerance*—Large variation in supply voltage is a good measure of margin in the system. Seven different supply voltages are used in the drive circuits. Each voltage can be varied better than ±10%. The system also performed satisfactorily when all the supply voltages were set 10% higher and 10% lower than their normal values, which represented their worst combinations.

6. *Temperature Performance*—The memory system consisting of the horizontal access circuits, the core array, and vertical access circuits was tested at two temperatures, 30 F and 140 F. The system performed satisfactorily at these temperatures. In addition, all the supply voltages can be varied approximately 10%.

VISUAL DISPLAY UNIT

To facilitate testing and also to check the operation of the memory system, a monitoring device was placed into operation with the memory. The unit provides a visual display of the information circulating in the memory system. The bits are plotted on *X*, *Y* coordinates in the screen of a cathode ray tube in direct correspondence with the core locations. Fig. 14 shows 40 bits distributed throughout 5 time slots as obtained in an actual memory application.

CONCLUSION

A high-speed ferrite core memory system has been designed to provide reliable operation with voltage tolerances of ±10% over a temperature range of 30 to 140 F. The system installed in a practical application is shown in Fig. 15. A life test is presently being conducted and the system has been operating successfully without any component failures for more than 3,600 hours. The high degree of reliability has more than met the design objective.

New Cable Winder

A new cable winding machine, developed by the Boeing Airplane Company, is producing flexible electric cable up to a maximum diameter of 1¼ inches at the company's missile production center in Seattle, Wash. Four-layer cables, containing a maximum of 84 wires of no. 16 gauge or smaller, plus core, can be turned out at a rate of about 15 feet per minute.

The machine consists primarily of four aluminum discs, each carrying a number of gimbaled wire spools. The discs are mounted on varying sizes of steel tubing and driven in opposite directions by geared line shafts through chains and sprockets to achieve a complex contrahelical lay—each layer spiraled in the opposite direction from its neighbor beneath. Threading is facilitated by ¼-inch tubes running from each wire spool disc to the front of the machine. Proper lay is maintained by a 14-inch-diameter pulley, which pulls the cable forward at the proper speed ratio to the rotating discs. Cable is automatically taped as it emerges from the forming die.

Application and Operation of D-C Drilling Rigs

E. E. HOGWOOD, JR.
ASSOCIATE MEMBER AIEE

The application of electric equipment to drilling rig drives can be made more economical if closer consideration is given to the engine, load, and method of operation. The information presented, which was derived from an analysis of actual operating test data, should assist users, rig builders, and operators in applying and operating electric drives more effectively on drilling rigs.

THE d-c variable voltage drive for diesel- or gas-electric drilling rigs has gained considerable popularity since the introduction of lightweight low-cost electric equipment. However, quite often not sufficient advantage has been taken of the intermittent capability of the generators and motors, both from an application and operational standpoint.

ELECTRIC EQUIPMENT SELECTION

THE ELECTRIC EQUIPMENT selection for a diesel–electric drilling rig should first recognize the over-all power requirements. Formerly, the hoisting load was predominant and its size influenced the selection. On modern drilling rigs, the mud pumps are the largest single load; thus, their horsepower requirements are a deciding factor in the choice of type and number of engine–generator sets for the power plant. Two, three, or four sets are usually selected, depending on engine size, degree of reliability desired, and the load requirements. Once the engines are selected, the generators, motors, and control should be chosen. The generators will be discussed first, because they are the first link in any electric drive system or transmission.

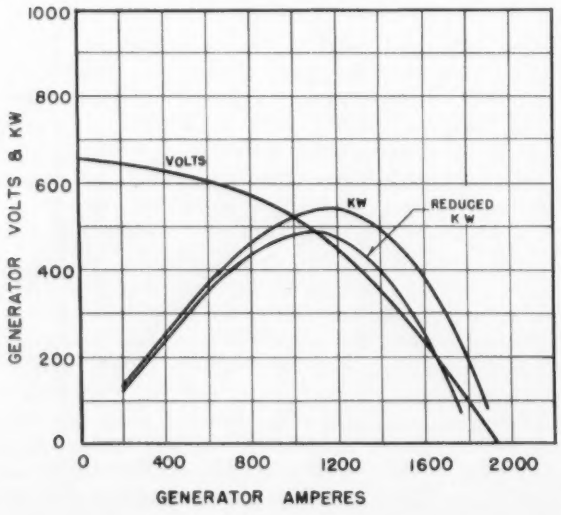

Fig. 1. Performance curves of one 550-kw d-c generator for use on drilling rigs.

Generators. The first requirement in the selection of the d-c generator is that it have characteristics which will suitably match the engine. An engine is essentially a constant-torque machine from which variable horsepower can be obtained by speed variation. Its rated horsepower is obtained at maximum rated speed; therefore, it is important that the generator match the maximum continuous horsepower and speed of the engine. Second, the generator output volts and ampere rating or some multiple of either must also match those of the motors being considered.

Fig. 1 shows the desirable volt–ampere and kilowatt–ampere characteristic for a drilling generator. The engine horsepower is expressed in generator output volts and amperes. The generator voltage is maximum at zero current and decreases or droops with increased load to a minimum when the current is greatest. This generator characteristic fixes the maximum no-load speed and stalled torque developed by a separately excited motor connected to it. The motor performance curve is very similar to this curve, with volts and amperes being replaced by speed and torque, respectively. Also, this characteristic limits the peak engine load to a value which can be preset by simple adjustment of the maximum generator excitation. The product of volts and amperes results in the kilowatt curve shown. As the load amperes increase, the engine loading first increases to a maximum, and then decreases. The engine is unloaded at both low and high currents and is fully loaded on a small portion of the curve. Therefore, the generator should be selected so that its peak kilowatt value exceeds slightly the continuous output of the engine. Five to ten per cent overload on the engine at peak kilowatt conditions is permissible and desirable when required. Overloading allows the system to operate at or near peak power over a wide load range.

The electrical rating of the generator is established on the basis of a continuous ampere load and a per-

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missible temperature rise. It is usually not possible to take advantage of the full intermittent capability of the generator, even on cyclic loads, because it is desirable to limit the maximum loading on the engine. The generator kilowatt rating converted to horsepower should match the continuous output of the engine.

During recent years, available generator frames and ratings have led to the application of one or two types of generators to a wide range of engine sizes. This procedure has many advantages for both the user and the electric equipment manufacturers. First, it offers low-cost low-weight, electric equipment on a short-delivery basis. Second, it is possible to adjust the generator peak output so that a number of different oil field engines can be matched. Third, the motors and generators are practically duplicates, thus minimizing spare parts requirements. Fourth, any necessary repairs can be handled quickly in the repair shops because of available standardized parts.

Motors. Consideration must be given to the drive requirements when selection of the motor is made. In the case of the drawworks, for example, the load is intermittent, with essentially constant horsepower in the operating range, and requires a certain maximum pull for stuck bit and a certain maximum speed for light hook operation. Fig. 2 shows a typical curve for a large drawworks specifically designed for an electric drive. This curve shows the performance of two 1,000-hp motors receiving power from three 800-hp engine-generator sets. The drawworks has only four forward gear ratios and no reverse gear since reversing is accomplished electrically.

The drawworks is usually rated in input horsepower (while hoisting), based on the load and resultant hoisting speed. This rating may be expressed as hoisting power and is calculated by the following equation:

$$\text{Hoisting power} = \frac{P_L N_L}{33{,}000\ E_{DW}}$$

where

P_L = Fast line pull in pounds

N_L = Fast line speed in feet per minute

E_{DW} = Efficiency of drawworks

Since the load requires this hoisting power for a variable length of time after which there is a semifixed interval of no-load time for "breaking-out" the stand and setting it aside, the drawworks motor may be applied with a continuous horsepower rating considerably below the drawworks horsepower rating.

The amount of power that the motor can transmit to the drawworks on an intermittent basis depends on (1) its designed capabilities from a maximum torque and maximum speed standpoint, and (2) the amount of power available from the engine–generator sets. The motor is designed to carry a continuous current under load conditions without exceeding a maximum safe temperature. Applied to the drawworks it does not carry current for the entire hoisting cycle; therefore, it can carry considerably more than rated current during the hoisting portion without causing any thermal damage to the insulation. The maximum current that a given motor can carry, regardless of the duty cycle, is determined by commutation. Also, the maximum voltage which can be applied to the motor is determined by the point where either flashover or serious overspeeding occurs.

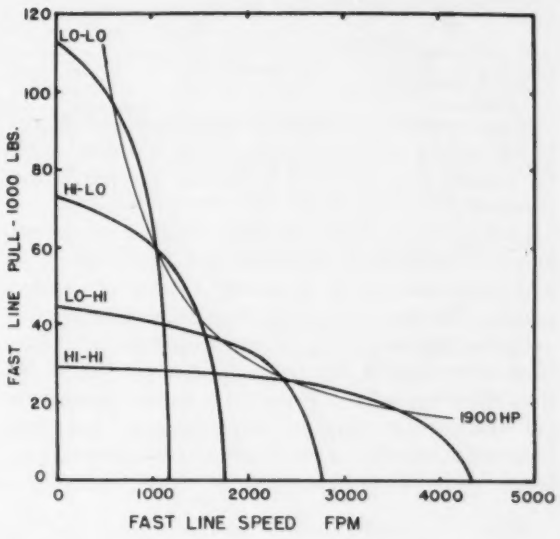

Fig. 2. Performance of two 1,000-hp motors on a large drawworks.

A motor then can receive power from one or several engine–generator sets and deliver more output to the drawworks on a short-time basis, as long as the safe maximum current and voltage ratings are not exceeded and the effective current is held to rated amperes or less.

The effective current which establishes the amount of heating that the motor can withstand is defined as the root mean square (rms) of the instantaneous currents for a given duty cycle. For instance, Fig. 3 shows the current trace of two drawworks motors connected in series for two successive hoists. Hoist no. 1 is in "Lo-Hi" gear, hoisting 5-inch drill pipe from 5,590 feet. Hoist no. 2 is in "Hi-Hi" gear, hoisting essentially the same load from 5,500 feet. The rms ampere value for each cycle is determined by using a mean value of current I_m and assuming this current is required during the hoisting portion of the cycle. This is an approximation, but is close enough for application purposes.

$$I_{rms} = \sqrt{\frac{I_m^2\, t_h}{t_h + t_r}}$$

where

I_m = mean amperes during hoisting portion of cycle

I_{rms} = effective current in amperes

t_h = hoisting time in seconds

t_r = rest time in seconds

For hoisting cycle no. 2 of Fig. 4:

$$I_{rms} = \sqrt{\frac{(1{,}300)^2 \times 23.3}{23.3 + 33.3}} = 832 \text{ amperes}$$

This calculation is based on force-ventilated motors. If the motors were self-ventilated, the rest time would be reduced by a factor of 4, because the heat cannot dissipate as rapidly.

Each motor on which this data was taken is rated 960 amperes continuous; therefore, the peak current of 1,470 amperes and the "running" current of approximately 1,350 amperes for this hoist are satisfactory.

On the rms ampere basis, higher currents could have been taken during this hoist, because the rms is less than the rated current. However, it will be shown later that the driller obtained approximately maximum horsepower transfer to the drawworks by using a "running" current of 1,350 amperes.

Motor Application Factor for Drawworks. An analysis of test data taken over a period of many years indicates that approximately 85 to 90% of the hoisting cycles are in the 20 to 60% "on" classification. In other words, the motor is delivering power to the drawworks from 20 to 60% of the total time per stand and is resting from 80 to 40% of the total time. Of course, the time "on" per stand varies with the amount of power on the rig, the load, and the gear ratio; however, a conservative cycle is estimated to be 50% on and 50% off. The hoisting motor gains additional cooling after completing a round trip because it is usually at rest with full ventilation or else rotating the bit at light load. This adds conservatism to the factors used in determining the actual horsepower rating of the motor for the drive.

Based on the foregoing, it is our practice to apply drawworks motors so that they develop approximately 140 to 145% of their continuous rating on a 50-50 hoisting cycle. This is conservative enough to handle normal hoisting without allowing the rms current to exceed rated current. An application factor of 1.4 to 1.45 for the drawworks motor means that one 1,000-hp continuous rated electric motor can drive a drawworks with a rating of approximately 1,400 to 1,450 hp if the chain ratios are properly selected and sufficient power is provided.

Motor Application Factor for Mud Pumps. The mud pumps are designed for an input horsepower based on a maximum speed in strokes per minute and a maximum force in pounds. Built-in protection in the form of a pressure relief valve or shear pin is usually provided by the pump builder to protect the pump against overstressing the mechanical parts when high loads exist. Since this pressure relief is usually set at approximately 25 to 30% above rated pressure, the electric drive system should have built-in torque limit to prevent unnecessary operation of the pump protective device under these conditions. This is accomplished by the generator characteristics as previously discussed.

The running load of the mud pump is sufficiently continuous to warrant an application factor of unity for the mud pump motor. This means that a 1,000-hp motor should be applied on a pump requiring 1,000 hp rated input. For reasonably long periods the pump will be operated at full load and speed. Strictly speaking, however, the pump is not running on a continuous basis for longer than approximately 2 hours; therefore, by applying an electric motor at the same rating as the pump input rating, a conservative margin exists to provide extra capacity when an emergency demanding an overload arises.

It is usually more economical to apply one motor than two on any large drilling rig drive. In some instances, a motor has been applied to a pump having a rating higher than that of the motor. If the difference in rating is not too great and it is recognized that the motor rms current must not exceed the rated ampere value during overloads, this application is justified for the economical gain.

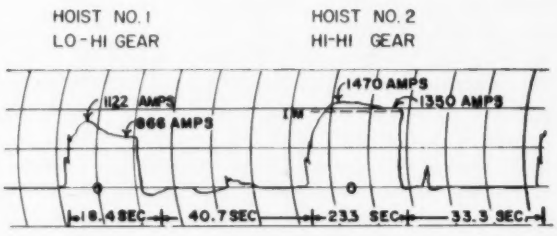

Fig. 3. Amperes vs. time for two successive hoists by two 1,000-hp motors.

Motor Application Factor for Rotary Table. The maximum torque delivered to the drill pipe by the rotary table must be controlled to prevent it from twisting off. Likewise, it is desirable to limit the maximum rotating speed to provide adequate control when "fishing" or drilling in peculiar formations. Variable speed is important to provide the correct speed for best penetration rate. Therefore, from a speed and torque standpoint, the requirements of the rotary table are very similar to those of the mud pump.

The running load of the table, as in the case of the mud pump, is sufficiently continuous to warrant an application factor of unity. It may be driven directly by a separate motor or from the drawworks. If separately driven, the maximum torque supplied by the motor and the chain ratio from the motor to the table may be selected so that the torsional limit of the drill pipe will not be exceeded. If the table is driven from the drawworks, some means of torque adjustment on the drawworks motors must be provided to provide this protection, because the rotary table load is relatively low in comparison to the hoisting load. This can be accomplished automatically when the driller operates the "Drill-Hoist" selector switch by reducing the number of generators available to the drawworks motor

when drilling or by inserting resistance in the generator field circuit to limit the excitation.

Control. The selection of the control system depends upon several considerations. The first is the degree of power flexibility required on the rig. The control can be arranged so that the generators may be switched to any motor on the rig or to only one motor. Of course, these are extreme examples of flexibility; however, some operators have deemed it justifiable to provide 100% flexibility. For most rig applications, some intermediate degree of flexibility is usually satisfactory.

Certainly, all or almost all the generators on the rig should be connectable to the drawworks motor(s) and perhaps to one large pump. This will provide full power should any one of the engine–generator sets fail. Of course, the degree selected depends on the user's desire and the amount of insurance required. For instance, in offshore applications, the additional expense of having each motor connectable to all generators is usually justified as is extra generating capacity in the power plant on the basis that downtime is much more expensive than the additional investment.

A second consideration is the over-all simplicity of the control system. Most operating and maintenance personnel are not sufficiently trained as yet to handle the more complex schemes available to the electrical design engineer today. For that reason the control system should be as simple as possible and yet provide the necessary operational and protective features for the equipment and personnel.

By simplicity is meant the desirability of having the control and machine characteristics as much a part of the inherent system as possible without additional rotating machines, relays, regulators, air systems, slide valves, air actuators, and systems requiring critical adjustment. With characteristics built in the main generators or into static, easily adjusted systems, the operating personnel have a minimum of concern about how to find and fix a trouble, because troubles are minimized. With the saturable reactor, magnetic amplifier, silicon rectifiers, and other "no-moving-parts" devices, simple, easily understood control systems can and are being built today to minimize down time due to component failures in the control system. The machine tool industry has found these systems invaluable from a maintenance standpoint and there is no reason why such systems cannot be applied on drilling rigs to provide improved control systems.

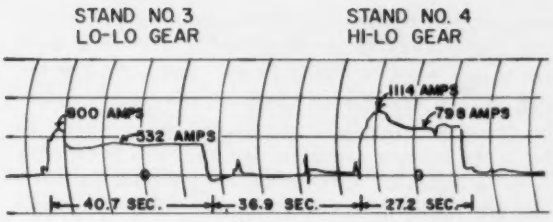

Fig. 5. Amperes vs. time for stands 3 and 4 from 10,000 feet.

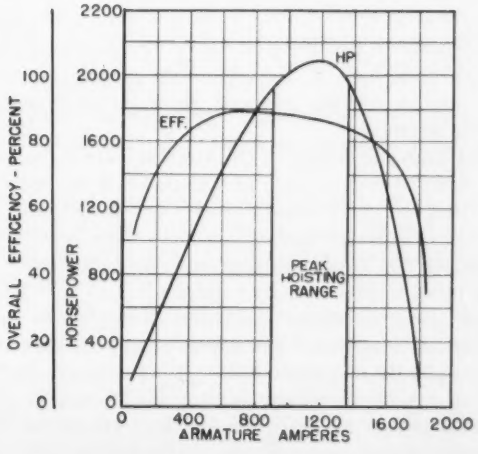

Fig. 4. Peak hoisting range for two 1,000-hp motors.

DEVELOPMENT OF OPERATION

Since the motors and generators serve as an electrical torque converter between the engine and driven equipment, it is well to analyze their performance for methods of improved operation. As noted earlier, the d-c generator automatically limits the peak loading on the engine by limiting its own maximum output.

Fig. 4 shows the over-all electrical efficiency from generator input to motor output and horsepower output for two 1,000-hp motors receiving power from three 550-kw generators. It will be noted that the efficiency of the system is highest through the range of maximum horsepower, and is similar in many respects to the efficiency curve of a hydraulic torque converter. This indicates that the optimum operating range is near the peak kilowatt output of the generator or peak horsepower output of the motor, where maximum power will be transmitted to the drive. This range is shown between 900 and 1,350 amperes, and is intended to be used only on an intermittent basis. It is not to say that higher amperes should not be used, for if the load requires 1,700 to 1,800 amperes for high torque pulling, then it can be supplied on a momentary basis. However, for maximum horsepower transfer to the hoist, the running current should be between 900 and 1,350 amperes for the motors in this example.

This is particularly important on the drawworks during hoist, because a significant saving in time can be made if the driller changes to a higher speed gear ratio at the right time. The equipment not only will be operated near peak efficiency, but it also will transmit peak horsepower from the engines, resulting in minimum hoisting times. Such operation is best for the electric equipment, because it will not be overloaded on an rms basis, but will allow full utilization of its intermittent capacity at peak performance on intermittent loads.

A suggested method of operation for the driller is to

have the drawworks ammeter marked in green for the peak horsepower range of currents, red above peak horsepower marked "Shift Down" and yellow below peak horsepower marked "Shift Up." In this manner, the driller will not have to make a test shift when he thinks the hoisting speed can be improved. It can definitely be improved with one shift if the ammeter markings are made taking into consideration the motor performance and the gear ratios of the drawworks.

On some recent tests in the Gulf of Mexico, it was noted that the driller hoisted the first three stands in Lo-Lo gear from approximately 10,000 feet with 2,000 hp available to the drawworks. From the data shown in Fig. 5 of stands 3 and 4 for this hoist, it is evident that stand 3 could have been hoisted in Hi-Lo or even Lo-Hi gear from an ampere and maximum horsepower standpoint. Also later, during the same "round trip," the driller made two test shifts trying to get into a higher speed ratio, whereby some lost time was incurred. Finally, the shift to Hi-Hi gear was made approximately 10 stands too early, causing the loss of an additional minute. Although the total time lost was only a few percent of the total, a number of round trips could account for a considerable length of time.

CONCLUSION

IN SUMMARY, the application of electric equipment to drilling rig drives can be made more economical if closer consideration to the engine, load, and electric equipment is given. The generator should provide as close a match as possible with the engine, in order to transmit maximum horsepower at highest efficiency. The motors should be selected on the basis of the load, so that in cases such as the drawworks, the intermittent capability of the motor can be used. On the mud pumps and the rotary table, the maximum torque and continuous horsepower requirements must be considered. Selection of the control system should be made on the basis of simplicity with a minimum of parts, to provide the desired degree of flexibility and protective features.

Consideration should also be given to the method of operation used by the driller. For peak horsepower transfer and optimum operating efficiency, the driller should shift gears on the drawworks at the time at which maximum benefit can be gained. This point will be considered when the application is made if the rms capacity of the motor is utilized. By recognizing these points and taking advantage of them, the builder, user, and operator of modern electric rigs can all benefit.

Tiny Atomic Generator Undergoes Stiff Tests

SNAP-3, the pint-sized atomic generator unveiled in January 1959 at the White House by the U. S. Atomic Energy Commission, was still producing electricity after a full year of continuous operation. Originally, the unit was intended to demonstrate maintenance-free operation over a period of only about 140 days. The life of chemical batteries of comparative size is limited to a few weeks.

Films released by the Nuclear Division of The Martin Company also showed a series of rigorous tests in which SNAP-3 units successfully survived the types of jolts they would undergo during a rocket ride into space.

Eight SNAP-3 generators have now been produced, but only two of them have been loaded with radioisotope fuel. Others were equipped with electric heating devices and subjected to vibration tests, sharp impacts, and accelerations up to 15 g. They also operated successfully in a vacuum at —100 F. The term "SNAP" stands for "System of Nuclear Auxiliary Power."

In SNAP-3, heat produced by the radioactive decay of 1/10 ounce of polonium-210 is converted directly into electric energy by a series of thermocouples. Since it contains no moving parts, it needs no maintenance during operation.

Although the output of the original SNAP-3 generator has dropped to a fraction of a watt, Dr. J. G. Morse of Martin-Nuclear's Isotopic Power Department said that the use of radioisotopes which decay more slowly than polonium-210 could prolong operation without any substantial change in size or weight.

Dr. Morse predicted that most of the applications for radioisotope-fueled generators during the next decade would lie in ground-based or water-based devices, but that nuclear power sources would also play an important role in space exploration. He added that isotopic power units appear to offer greater reliability than solar cells.

A Study of the Effects of Corona on Polyethylene

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THE DELETERIOUS EFFECT of corona on the insulation of wires and cables subjected to high voltages has long been recognized. This basic work was undertaken to investigate the effects of corona on commercial Fawcett-type polyethylenes (branched high-pressure free-radical polymers) used as insulation in high-voltage applications. Two questions were to be answered. What are the factors involved in the design of a high-voltage cable? What are the criteria for selecting the best polyethylene resin for this use?

These studies revealed the existence of a phenomenon which we now call "electromechanical stress cracking." It might be more descriptively termed "corona-mechanical stress cracking." This effect may be demonstrated by carefully wrapping an insulated wire spirally about a grounded mandrel and applying sufficient voltage to cause corona. The failure always occurs in the insulation which is under tension and not at a point adjacent to the mandrel as would be expected. The many variables in the mandrel test are difficult to control. A simpler test method was devised in which a film sample is stretched to give essentially uniaxial strain. Then an electrical stress is applied through the film at right angles to the mechanical strain. Relative corona life by this method correlates with that from the mandrel test. Also, the stretched film arrangement allowed the use of direct electrode voltage endurance methods to study the effects of corona on insulating materials.

This investigation has involved to date approximately 400,000 sample exposure hours. The following conclusions have been drawn from these data:

1. Corona life of a given polyethylene under a constant amount of corona is a function of the mechanical strain in the sample exposed. Life is decreased as the amount of mechanical strain is increased.

2. Initial mechanical stresses within the insulation may be relaxed by exposure to elevated temperatures and, thus, corona life extended.

3. The effect of voltage stress in causing failure is an indirect one; the corona which it produces is the active agent.

4. Failure under corona is a surface effect and not an internal one. In the case of voids in the body of an insulation, corona attack is on the inside surface of the void.

5. Corona must be suppressed to get indefinitely long life under voltage. Furthermore, corona-free electrical stresses on polyethylene insulation can be surprisingly high and still result in indefinitely long life.

6. When samples are elongated and exposed to corona, failure follows the development of surface cracks perpendicular to the direction of elongation. In an unelongated sample, the mechanism of failure is radically different; failure occurs because of progressive erosion of the insulation surface by ion bombardment, which leads to decreased insulation thickness.

7. For a given voltage level causing corona, corona life of specimens in air is a strong function of the humidity. A relative humidity (R.H.) of 95 to 100% gives approximately 15 times longer life than dry air. The apparent reason for this somewhat surprising result is the development of a semiconducting surface layer under humid condition which grades the fields and diminishes the corona intensity.

8. At a given voltage level, nitrogen at atmospheric pressure results in longer corona life than air. Again, increased humidity augments life considerably. Corona life under the test conditions of 200 volts per mil and 50% elongation was considerably longer under 100% R.H. nitrogen than any other atmosphere. Again, the establishment of a semiconducting layer during initial stages of corona bombardment essentially extinguished subsequent corona.

9. The addition of small amounts of carbon black to the polyethylene to improve resistance to weathering decreases corona life.

The work described here is primarily basic research and the test specimens bear little physical resemblance to cable insulation. However, the data obtained and the conclusions drawn are directly applicable to the design and manufacture of cable, as follows:

1. Cables should be designed to be free from corona under service conditions. This means absence of either internal voids or space where corona can occur next to strand or shield.

2. The existence of the "electromechanical stress crack" phenomenon means that

A. Fabrication by the cable manufacturer should be carried out to give an absolute minimum of residual strain, so that the insulation will have maximum resistance to any possible corona.

B. The user might take steps to relax the stresses caused by bends and installation handling. This can be done by heating the cable by conductor resistance losses prior to voltage application. Even if this is not done, however, serious damage is not likely to occur since both time and temperature lead to relaxation.

Digest of paper 59-800, recommended by the AIEE Insulated Conductors Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer and Pacific General Meeting and Air Transportation Conference, Seattle, Wash., June 21-26, 1959. Published in AIEE *Communication and Electronics*, Nov. 1959, pp. 654-62.

E. J. McMahon, D. E. Maloney, and J. R. Perkins are with E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

INSTITUTE ACTIVITIES

Southwest District 7 Meeting

To Be Held April 4-6 in Houston, Texas

Photocolor

THE EVER-GROWING skyline of Houston, Texas, largest city in the South and host for the AIEE Southwest District 7 Meeting this year, is pictured. Headquarters for the April 4-6 meeting will be the luxurious Shamrock Hilton Hotel in Houston.

HOUSTON, TEXAS will welcome AIEE members and their wives who attend the Southwest District 7 Meeting, scheduled for April 4-6, 1960, at the Shamrock Hilton Hotel.

Founded in 1836, Houston was once the capital of the republic of Texas and is adjacent to the site at which the State won its independence from Mexico. Now the largest city in the South, with a metropolitan area population of almost a million and a quarter people, the name of Houston has become synonymous with dynamic growth. Towering skyscrapers in various stages of completion, bustling commercial enterprises, and a vast industrial complex illustrate well the role of modern-day electrical engineering and add significance to the comprehensive technical program to be featured at the District 7 meeting.

Carefully chosen technical presentations conducted by leading authors from all sections of the country will cover more than 80 timely and important fields of interest, all keyed to the theme "Electricity—Pacemaker of Industrial Growth in the Great Southwest." Inspection trips to local industries and down the Houston Ship Channel will offer a comprehensive look at modern applications of engineering principles.

A varied program of entertainment has been planned to supplement the technical presentations. For the men, the facilities of several Houston golf courses have been made available.

Ladies' Program

Highlights of the ladies' activities include a fashion program and book review by one of Houston's outstanding artists. The ladies' complete program is:

Monday, April 4

10:00 a.m. "Let's Get Acquainted" Coffee Hour

Walnut Room, 3rd floor, Shamrock Hilton, no admission charge.

12:30 p.m. Luncheon

Satsuma Room, 1st floor, admission $3.50. Fashion Program — immediately following luncheon, "Neiman Marcus Presents Ann Randall, Fashion Advisor," Satsuma Room, included in luncheon admission.

Tuesday, April 5

10:30 a.m. Visit

New Houston Engineering and Scientific Society Building.

11:00 a.m. Social Hour

11:30 a.m. Brunch

Book Review by Margaretta Bolding, admission $2.50.

Reservations for each day's events must be made before 9 a. m., Monday, April 4, so it is suggested that the men purchase their wives' tickets at the time they register.

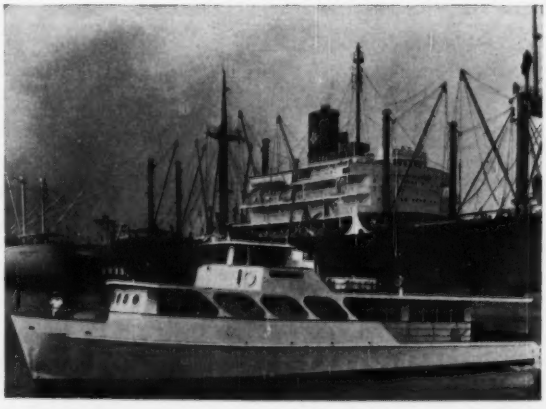
Transportation for the Tuesday affair will be provided by local members, and ladies planning to attend should meet at 9:45 a. m. in the Hospitality Room (Walnut Room).

Out-of-town guests may visit special places of interest in the city by making arrangements with Mrs. T. M. Keiller, who will be present Monday morning.

Ladies may also accompany their husbands on either of the boat trips down the Houston Ship Channel.

Registration

The Meeting Registration Booth and Information Center will be located in the North Lobby of the Shamrock Hilton on Sunday. On Monday and thereafter, they will be located at the entrance of the Hall of Exhibits. Registration will begin on



Pervin Photo

THE M. V. Sam Houston (foreground), official Port of Houston inspection boat, will carry AIEE members on inspection trips of the Houston Ship Channel. The excursions will get underway from the turning basin and terminate at the San Jacinto Battleground where Texas' independence was won. Along the way, myriad industries will be seen, giving ample evidence of the channel's role.

Sunday, April 3, from 3 until 6 p. m., then continue through each day of the convention. Registration fees are $4 for members, $7 for nonmembers and $2 for ladies. All persons planning to attend have been urged to return their Advance Registration Forms promptly to: H. W. Magruder, General Electric Company, P. O. Box 22045, Houston 27, Texas.

General Meeting

Activities officially begin with the general meeting at 10 a. m. Monday. Featured at this session will be Houston Mayor L. W. Cutrer, AIEE President J. H. Foote, AIEE Vice-President I. T. Monseth, and Westinghouse Electric Corporation Vice-President Dr. J. A. Hutcheson, who will make the keynote address. The general meeting, for which there is no charge, will be held in the Continental Room.

A luncheon will follow in the Emerald Room at 12:00 noon with Prof. N. F. Rode, AIEE director, presiding. An entertaining and informative talk by a well-known speaker will highlight the luncheon. Admission will be $3.50 per person.

Banquet

On Tuesday evening, the social hour in the Grecian Room will be followed by a banquet in the adjacent Emerald Room. At the banquet, with P. H. Robinson, general chairman, presiding, members and their wives will have the pleasure of hearing the Lamar High School Mixed Chorus, a 100-voice singing group. A nationally-known speaker will climax this outstanding event, for which admission will be $7.50 per person, including the social hour.

Hotel Accommodations

Members are requested to return their reservation cards directly to the hotel promptly, since the Shamrock Hilton will not guarantee to fill reservations received after March 26.

Special room rates obtained are as follows:

Single	$ 8—$18
Double	$12—$20
Parlor and one bedroom	$25—$40
Parlor and two bedrooms	$55—$70

(in the event the room requested is not available, quarters having the next rate will be assigned)

Further information regarding hotel rooms may be obtained from W. M. Oliver, 507 Dallas Ave., Houston 2, Texas, who is chairman of the Hotel and Equipment Committee. If the reservation card should be misplaced, room arrangements can be made by contacting the reservation department, Shamrock Hilton Hotel, P. O. Box 1287, Houston, Texas.

Inspection Trips

Three inspection trips to leading industries, and unusual sight-seeing excursions down the Houston Ship Channel have been scheduled. To cover transportation costs, there will be a $2 charge per person for each trip. Capacity for each tour is 40 persons, with the exception of the boat trips which is 80 persons. If insufficient interest is evidenced in any inspection trip, such trip or trips will be cancelled.

Industrial Aerial Photo

A MONUMENT to electrical engineering, Southern Pacific's Englewood Radar Yard will be toured by AIEE members attending the Southwest District 7 Meeting. Utilizing radar and electronic computing equipment, the yard makes possible the switching and classifying of cars five times faster.

Houston Lighting & Power Company Steam Electric Generating Station (Monday, 2–6 p.m.) Located on a 664-acre tract near the San Jacinto Monument, the Sam Bertron Station is the largest plant on the Houston Lighting & Power Company's system. The plant's first generator of 165,000-kw capability was put into service in March of 1956. In 1958 another 165,000-kw machine was added, then a 220,000-kw unit in February 1959. The fourth generator went on the line in February 1960 to raise the total generating capability of the Bertron plant to 770,000 kw.

Primary fuel for the plant is natural gas, delivered at 500 psig and reduced to 75 and 50 psig for use. It has a heating value of 1030 Btu per cubic foot at standard conditions, and is introduced to the plant at an average specific gravity of 0.580.

Boiler capacities are 1.2 million pounds per hour for No. 1 and 2 Units, and 1.55 million pounds per hour for Units 3 and 4. Superheat and reheat temperatures for all four boilers is 1,005 F. The 165,000-kw turbogenerators have a throttle pressure of 1,800 psig, the larger units, 2,000 psig.

Sheffield Division, Armco Steel Corporation (Tuesday, 8:30 a.m.—12:30 p.m.). Construction of Sheffield's Houston mill began in 1941. It was completed in the following year, and the first heat of steel tapped on March 20, 1942.

Steady expansion of facilities has given the plant a capacity of 1.26 million tons of ingot steel per year. Open hearths belching 3,000 F temperatures and electric furnaces which noisily reduce scrap metal to liquid in an amazingly short time are spectacular highlights in the making of ingot steel which, ultimately, is processed into wire, plates, structural shapes, rods, and tank heads.

Englewood Radar Yard, Southern Pacific (Tuesday, 1:30 p.m.—5:30 p.m.). Recently expanded, Southern Pacific's Radar Yard facilitates the switching and classifying of freight cars five times faster than before. The yard has a capacity of 7,179 cars and occupies 359 acres containing 113 miles of tracks.

The radar and electronic computing equipment, which makes possible damage-free operations, in any weather, utilizes 49 miles of multiple-conductor cable and 280,000 feet of single conductor wire. Some 348 track switches, of which 96 are electrically controlled, are also installed. Sixteen floodlight towers containing 180 lighting units provide illumination rated at 40 million candlepower.

To construct the yard, 845,000 cubic yards of earth and selected materials were moved, and 29 prefabricated steel buildings and towers constructed.

Houston Ship Channel Excursion, M. V. Sam Houston (Tuesday, 1:30—5:30 p.m., and Wednesday, 8:30 a.m.—12:30 p.m.) Because of the expected popularity of a boat trip down the ship channel, two tours have been scheduled. Members will be delighted with the recently launched *M. V. Sam Houston*, which is the official Port of Houston inspection boat. Leaving from the turning basin, the boat will pass many of the largest industries of the area, including Sheffield Steel and Houston Lighting & Power Company's Deepwater Plant. The channel, which serves the second largest port in the United States, was once Buffalo Bayou, having been deepened to accommodate sea-going vessels in 1915. It is appropriate that the boat trips down the channel should be scheduled, since the opening of the port played such an important role in the growth of Houston and modern electrical engineering in the Gulf Coast area.

Members of District 7 Meeting committee are P. H. Robinson, general chairman; V. O. Clements, vice-chairman; J. B. Burr, vice-chairman; W. E. Silvus, budget and finance chairman; M. T. Robin, coordinating secretary; C. L. McNeese, pub-

THIS dramatic photograph of steelmaking at the Houston plant of Sheffield Division, Armco Steel Corporation, shows the last stage as a giant open-hearth furnace is tapped. The river of molten steel from the furnace—160 tons of it—has filled the huge ladle, and the white hot slag is being run off the top of the steel. The Sheffield plant will be toured by AIEE members

Bert Brandt & Associates

licity chairman; A. F. Williams, Section liaison chairman; L. K. Del'Homme, technical program chairman; H. P. Heafer, communications subchairman; Dana Price, general applications subchairman; W. D. Coxe, Chemical and Petrochemical subchairman; H. M. Stewart, Petroleum and Natural Gas subchairman; H. N. Hickok and L. V. Eidson, general industrial applications subchairmen; M. H. Lovelady, power subchairman; J. M. Bryan, maintenance subchairman; W. S. Miller, instrumentation subchairman; R. W. Olson, science and electronics subchairman; P. E. Pfeiffer, engineering education subchairman; W. M. Oliver, hotel and equipment chairman; C. M. Davis, registration and information chairman; W. F. Strong and J. R. Ridgway, Jr., inspection trips and transportation chairmen; G. B. Jamison, entertainment chairman.

Tentative Program

Monday, April 4

8:00 a.m. Registration—Entrance, Exhibit Hall

10:00 a.m. General Session—Continental Room

Presiding: I. T. Monseth, vice-president, District 7, AIEE

Welcome: L. W. Cutrer, mayor, City of Houston

Institute Progress: J. H. Foote, president, AIEE

Keynote Address: Dr. J. A. Hutcheson, vice-president, Westinghouse Electric Corp.

12:00 p.m. Luncheon—Emerald Room

Presiding: Prof. N. F. Rode, director, AIEE

Address by outstanding speaker

2:00 p.m. Afternoon Sessions

What is Happening in Electrical Engineering Education in the Southwest?—Azalea Room

Presiding: Prof. P. E. Pfeifler, The Rice Institute

Each speaker will deal with the theme question in the light of events, problems and plans in his own school. *G. D. Hallmark*, Texas A&M College; *F. W. Tatum*, Southern Methodist University; *Gerald Tuma*, University of Oklahoma; and *LeVan Griffis*, The Rice Institute.

Power System Engineering—Exhibit Hall

Presiding: G. E. Schmitt, Lower Colorado River Authority

DP60-517. Measurement of Flicker Resulting from Large Arc Furnace Operations.
D. E. Simons, Houston Lighting & Power Co.

DP60-528. Application of Computers in System Engineering.
G. W. Oprea, Houston Lighting & Power Co.

Power System Equivalents.
M. L. Johnson, L. M. Haupt, Texas A&M College

Panel—Determination of Firm and Spinning Reserve. *C. M. Custer*, Southwest Power Pool; *Frank Dillon*, Texas Power & Light Co.; *W. C. Siegelin*, Central Power & Light Co.; *Arnold Rich*, Federal Power Commission

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AIEE Order Department
33 West 39th Street.
New York 18, N. Y.

Communications—Bluebonnet Room

Presiding: E. G. Westheimer, Southwestern Bell Telephone Co.

Quality Control of Communication Circuits.
H. J. McMains, Southwestern Bell Telephone Co.

Communications Related to Pipe Line Operations.
Vinton Long, Texas Eastern Transmission Corp.

The Revolution in Communications.
K. M. Shouse, Southwestern Bell Telephone Co.

Illumination—Camellia Room

Presiding: E. B. Karns, Westinghouse Electric Corp.

Panelescent Application.
J. M. Harris, Sylvania Lighting Products

A Practical Approach to Roadway Lighting.
D. W. Rowten, Sylvania Lighting Products

High-Frequency Lighting.
R. W. Horner, The Wakefield Co.

Industrial Lighting.
C. L. Osborn, Westinghouse Electric Corp.

Tuesday, April 5

8:00 a.m. Registration—Entrance, Exhibit Hall

9:00 a.m. Morning Sessions

Petroleum and Natural Gas—Azalea Room

Presiding: C. E. Cunningham, Humble Oil & Refining Co.

Laurel Applies Automation Techniques on Product Pipeline.
K. E. Willson, Laurel Pipeline Co.;
H. N. Hickok, P. D. Woodruff, General Electric Co.

Gas—A Coming Source of Electric Energy.
H. H. Fitzgerald, D. E. O'Connor, Commonwealth Services Inc.

Utility Features of the Amoco Yorktown Refinery.
J. T. Cain, American Oil Co.

Relaying a Growing Refinery Power System.
H. L. Post, Humble Oil & Refining Co.

Power Transmission—Exhibit Hall

Presiding: J. E. Sheehan, City Public Service Board, San Antonio

Design, Construction, and Operation of Modern Dispatching Facilities.
J. B. Poston, City Public Service Board, San Antonio

DP60-529. Ground Line Treatment of Standing Transmission Line Poles.
J. M. Mabe, Central Power & Light Co.

Design Features of Modern Transmission Structures.
R. M. McCuistion, Houston Lighting & Power Co.

Evaluation of Extra-High-Voltage Transmission Systems.
D. J. Hubert, J. W. Yetter, General Electric Co.

Communications in Space—Bluebonnet Room

Presiding: C. R. Wischmeyer, The Rice Institute

60-518. Moon Reflection Studies with Bistatic Radar at 3,000 Kmcs.
A. W. Straiton, C. W. Tolbert, The University of Texas

Establishing a Space Communication Facility.
R. E. Anderson, General Electric Co.

A Photoelectric Observatory for Satellite Tracking.
J. F. Spaulding, General Electric Co.

Space Communications.
P. Swerling, S. Reiger, The Rand Corp.

AIEE Future Meetings

AIEE-ASME-I I of T American Power Conference*
Sherman Hotel
Chicago, Ill.
March 29-31, 1960

EJC Nuclear Congress
New York Coliseum
New York, N. Y.
April 4-7, 1960

Southwest District Meeting*
Shamrock-Hilton Hotel
Houston, Texas
April 4-6, 1960

Electrical Engineering in Space Technology Conference*
Hotel Baker
Dallas, Texas
April 11-13, 1960

Materials Handling Conference*
Sheraton Hotel
Philadelphia, Pa.
April 12-13, 1960

East Central and Allegheny-Ohio Valley District Meeting
Daniel Boone Hotel
Charleston, W. Va.
April 12-14, 1960

AIEE-ASME Railroad Conference*
Penn-Sheraton Hotel
Pittsburgh, Pa.
April 20-21, 1960

AIEE-ASME-IRE Automatic Techniques Conference*
Sheraton-Cleveland Hotel
Cleveland, Ohio
April 18-20, 1960

Paper and Pulp Conference*
University of Florida
Gainesville, Fla.
April 21-22, 1960

Rubber and Plastics Conference*
Sheraton-Mayflower Hotel
Akron, Ohio
April 25-26, 1960

Great Lakes District Meeting*
Pfister Hotel
Milwaukee, Wis.
April 27-29, 1960

North Eastern District Meeting*
Sheraton Biltmore Hotel
Providence, R.I.
May 2-4, 1960

AIEE-IRE-ACM Western Joint Computer Conference
Jack Tar Hotel
San Francisco, Calif.
May 3-5, 1960
(Final date for Initial Drafts—closed, Final Drafts—March 1)

AIEE-IRE-U of V Educational Frontiers in Biomedical Engineering Conference
University of Vermont
Burlington, Vt.
May 5-6, 1960
(Final date for TP—closed, ‡CP Syn.—closed, CPMs—March 1)

Spring Textile Conference
Georgia Institute of Technology
Atlanta, Ga.
May 5-6, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—March 1)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Washington, D. C.
May 10-12, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—March 7)

Farm Electrification Conference
Sheraton-Fontenell Hotel
Omaha, Nebr.
May 10-12, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—March 7)

Appliance Technical Conference
Leland Hotel
Mansfield, Ohio
May 16-17, 1960
(Final date for †TP—closed, ‡CP Syn.—March 2, CPMs—March 11)

Annual Cement Industry Technical Conference
Pfister Hotel
Milwaukee, Wis.
May 17-19, 1960
(Final date for †TP—closed, ‡CP Syn.—March 4, CPMs—March 14)

AIEE-ISA-ARS-IAS National Telemetering Conference
Marimar Hotel
Santa Monica, Calif.
May 23-26, 1960
(Final date for †TP—closed, ‡CP Syn.—March 9, CPMs—March 18)

World Power Conference
Instituto Nacional de Industria
Madrid, Spain
June 5-9, 1960

Summer General Meeting
Chalfont-Haddon Hall
Atlantic City, N. J.
June 19-24, 1960
(Final date for †TP—March 21, ‡CP Syn.—March 31, CPMs—April 15)

Pacific General Meeting
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960
Final date for †TP—May 10, ‡CP Syn.—May 20, CPMs—June 3)

Aero-Space Transportation Conference
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960
(Final date for †TP—May 10, ‡CP Syn.—May 20, CPMs—June 3)

AIEE-ASME Engineering Management Conference
Morrison Hotel
Chicago, Ill.
September 14-16, 1960
(Final date for †TP—June 16, ‡CP Syn.—July 1, CPMs—July 11)

AIEE-IRE Industrial Electronics Conference
September 21-22, 1960
(Final date for †TP—June 23, ‡CP Syn.—July 8, CPMs—July 18)

AIEE-ASME National Power Conference
Bellevue-Stratford Hotel
Philadelphia, Pa.
September 21-23, 1960
(Final date for †TP—June 23, ‡CP Syn.—July 8, CPMs—July 18)

Petroleum Industry Conference
Skirvin Hotel
Oklahoma City, Okla.
September 25-28, 1960
(Final date for †TP—June 27, ‡CP Syn.—July 12, CPMs—July 22)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 9-14, 1960
(Final date for †TP—June 10, ‡CP Syn.—July 21, CPMs—Aug. 5)

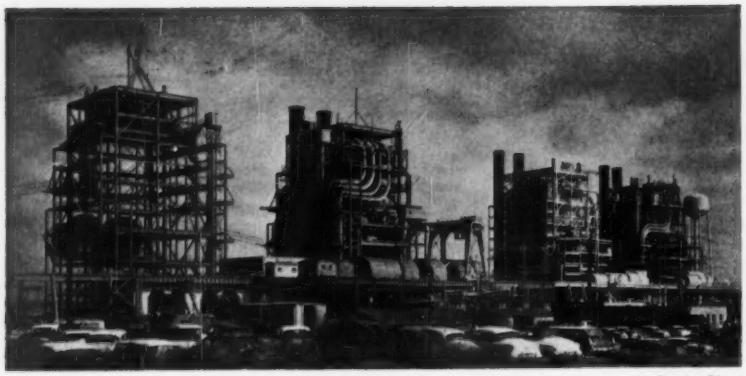
AIEE-IRE-EIA-SMPTE National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 10-12, 1960
(Final date for †TP—July 12, ‡CP Syn.—July 27, CPMs—Aug. 5)

1961 Winter General Meeting
Hotel Statler
New York, N. Y.
January 29-February 3, 1961
(Final date for †TP—Oct. 31, ‡CP Syn.—Nov. 10, CPMs—Nov. 25)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*
For a copy, write to E. C. Day, AIEE, 33 W. 39th St., New York 18, N. Y.



Pervin Photo

AN OPPORTUNITY will be given AIEE members to tour the Houston Lighting & Power Company's recently completed total outdoor Sam Bertron generating station. Located on the Houston Ship Channel, the plan utilizes steam turbines with natural gas fired boilers and has a total generating capability of 770,000 kw—largest in the power company's system.

Maintenance Symposium—Camellia Room

Presiding: J. M. Bryan, Humble Oil & Refining Co.

Maintenance as Seen by the Repair Shop People.
S. H. Segrest, Westinghouse Electric Corp.

Maintenance in a Petrochemical Plant.
E. R. Felton, Esso Standard Oil Co.

Maintenance in an Oil Refinery.
John Petkousek, Magnolia Petroleum Co.

Use of D-C Overpotential Testing as a Maintenance Tool in the Industrial Plant.
W. A. Weddendorf, Mutual Boiler & Machinery Insurance Co.

Chemical and Petrochemical Instrumentation—Azalea Room

Presiding: P. D. Woodruff, General Electric Co

Direct Volume Calculation of Storage Tank Capacities Corrected for Temperature and Specific Gravity.
J. P. Anthony Jr., Texas Instruments Inc.

Development of Low Maintenance pH System.
R. G. Sproston Jr., Shell Chemical Co.

A Pneumatic Force Balance System for Measuring Large Cell Line Currents.
H. C. Behrens, The Dow Chemical Co.

Power Generation—Bluebonnet Room

Presiding: W. G. Siegelin, Central Power & Light Co.

DP60-519. Operating Experience With Large Turbo-Electric Generators.
C. W. Anthony, Oklahoma Gas & Electric Co.

Data Logging and Automatic Control of Power Plants.
J. L. Warmack, Gulf States Utilities Co.

Automatic Control with a Digital Computer of a Large Steam Generating Station.
D. L. Aswell, Louisiana Power & Light Co.

Design of an Excitation System for Large A-C Generators.
J. A. Zimmerman, Allis-Chalmers Manufacturing Co.

Application of Hydro Pumped-Storage to an Interconnected Utility System.
G. J. Vencill, Union Electric Co.

Thermoelectric Energy Conversion—Exhibit Hall

Presiding: R. W. Olson, Texas Instruments Inc.

New Trends in Thermoelectricity.
B. B. Rosenbaum, U. S. Bureau of Ships

Theoretical and Experimental Performance of a Highly Developed Thermoelectric Generator.
K. C. Jordan, Mound Laboratory, Monsanto Chemical Co.

Engineering Considerations in the Design of Thermoelectric Coolers.
E. R. Boyko, W. J. Barr, American Radiator & Standard Sanitary Corp.

Thermoelectric Cooling and Power Generation.
S. J. Angello, New Products Laboratories, Westinghouse Electric Corp.

General Industrial Applications—Camellia Room

Presiding: L. U. Eidson, Westinghouse Electric Corp.

Portable Apparatus for Service Reliability in Industrial Systems.
J. Moriaty, Gulf Oil Corp.

Power Application in Driving a 24-Mile Tunnel.
G. O. Hughes, O. E. Lundelius, Brown & Root Inc.

The Expansion of the Power Distribution System of a Paper Mill.
J. W. McAnally, Champion Paper & Fibre Co.

Education and Maintenance in the Operation of Industrial Power Systems.
W. A. Weddendorf, Mutual Boiler & Machinery Insurance Co.

6:30 p.m. Social Hour—Grecian Room

7:30 p.m. Banquet—Emerald Room

Presiding: P. H. Robinson, general chairman, District 7 Meeting

Entertainment: Lamar Mixed Chorus

Address by prominent speaker.

Wednesday, April 6

8:00 a.m. Registration—Entrance, Exhibit Hall

9:00 a.m. Morning Sessions

Chemical and Petrochemical—Exhibit Hall

Presiding: W. C. Woods, Westinghouse Electric Corp.

A Recent Look at European Industrial Electrical Power Practices.
R. L. Sandstedt, Monsanto Chemical Co.

DP60-527. Evaluation of High-Capacity Semiconductor Rectifier Devices.
J. L. Boyer, W. S. Albert, Westinghouse Electric Corp.

DP60-520. Economic Analysis of Chemical Plant Wiring Methods for Low-Voltage Power and Control Systems.
A. A. Johnson, The Dow Chemical Co.

Automatic Current Control of Ignitron Rectifiers in Electrochemical Service.
B. J. Nankervis, The Dow Chemical Co.; *L. U. Eidson*, Westinghouse Electric Corp.

Remote Operation of a Rectifier Substation.
R. P. Triche, R. P. Love, Ethyl Corp.

Power Distribution—Bluebonnet Room

Presiding: R. W. Sherwood, Gulf States Utilities Co.

Service to Large Commercial Loads from 265/460-Volt Spot Networks.
J. P. Barron, Dallas Power & Light Co.

New Approach to Comparative Economics of Secondary Shunt Capacitors.
F. J. Meyer Jr., Public Service Company of Oklahoma

Effect of Loading and Loss Ratio on Cost of Losses of Distribution Transformers.
A. M. Lockie, Westinghouse Electric Corp.

DP60-521. Practical Application of Digital Computers to Distribution Systems.
T. L. Hatcher, E. L. Busby, Texas Power & Light Co.

Future Power Sources—Azalea Room

Presiding: Prof. W. H. Hartwig, University of Texas

Fuel Cell Batteries—A Review.
J. J. Murphy, C. H. Clark, A. F. Daniels, U. S. Army Signal Research and Development Laboratory

The Plasma Cell and Nuclear Electric Conversion.
W. A. Ranken, University of California, Los Alamos Scientific Laboratory

Magnetohydrodynamics Power Generation.
Stewart Way, Westinghouse Research Laboratories

Comparison of Two Particle Distributions.
W. J. Graff, Southern Methodist University

Industrial Computer Control—Camellia Room

Presiding: H. N Hickok, General Electric Co.

Fundamentals of Digital Control and Measurements System.
A. H. McMorris, University of Houston

Recent Advances in Pipeline Pump Station Automation.
R. D. Pfluger, Shell Pipe Line Corp.

New Digital Computer Techniques Solve Industrial Problems.
C. J. Baldwin, Westinghouse Electric Corp.

Computer Control for Power Generation.
R. G. Livingston, General Electric Co.

2:00 p.m. Afternoon Sessions

Chemical and Petrochemical—Camellia Room

Presiding. D. J. Hubert, General Electric Co.

Converting an Air Compressor Steam Generator Station for Unattended Operation.
K. Blythe, Reynolds Metals Co.

DP60-522. Electrical Maintenance in a Chemical Plant
A. D. Colburn, Union Carbide Chemicals Co.

DP60-523. Operating Record of Sealed Tank Mercury Arc Rectifiers.
B. D. Cockrell, E. S. Manning, Aluminum Company of America

DP60-524. Lighting and Instrument Service Branch Circuit Design for Chemical Plants.
J. H. Wieting, Union Carbide Chemicals Co.

Power Substations and Relaying—Bluebonnet Room

Presiding: J. K. Howell, Westinghouse Electric Corp.

DP260-525. Design of Transformer Vault Buses.
R. O. Randle, Houston Lighting & Power Co.

DP60-526. A Reclosing Relay for Ring Bus Substations.
L. A. Davidson, V. M. Hines, Oklahoma Gas & Electric Co.

DP60-530. Control of Flicker on Distribution Systems.
L. R. Gardner, Houston Lighting & Power Co.;
W. T. Kittinger Jr., University of Houston

The New Static Overcurrent Relay.
F. T. Free, N. Kreekon, Allis-Chalmers Manufacturing Co.

Materials Technology; New Uses For Electric Energy—Azalea Room

Presiding: Prof. J. D. Horgan, Marquette University

Semiconductor Materials Chemistry.
R. E. Johnson, Texas Instruments Inc.

New Electronic Devices from New Semiconductor Materials.
R. L. Petritz, Texas Instruments Inc.

Implications of Whiskers Research in Materials Technology
W. W. Webb, Union Carbide Metals Co.

Electron Beam Welding, Drilling, and Milling, Using High Voltages and Sophisticated Optical Systems.
K. H. Steigerwald, Electrona Inc.; Carl Zeiss (of Germany).

General Industrial Applications—Exhibit Hall

Presiding: H. C. Morton, Westinghouse Electric Corp.

The Electrical Modernization of a Growing Port.
Dwain Orr, Corpus Christi Navigation District

Application of New Electronic Developments to a High Performance Aircraft.
D. C. Thomas, Chance-Vought Aircraft Corp.

Nuclear Magnetic Resonance Instrumentation for Industrial Growth.
William Rollwitz, Southwest Research Institute

Recent Developments in Nondestructive Testing Using Magnetic Techniques.
Lyle Donaldson, Southwest Research Institute

Two-Way Radio Communications for the Texas Highway Department.
M. J. Green, H. E. Bovay Consulting Engineers

Traffic Problem Studied at Michigan Section Meeting

Prof. H. H. Goode addressed the Michigan Section, AIEE, at the January Section meeting in Ann Arbor, Mich. His topic was "Simulation of Traffic by Digital Computer with Oscilloscopic Output."

Prof. Goode emphasized the need for new methods to solve the ever-increasing traffic problems. At the present time the traffic engineer is able to handle single intersections with a reasonable assurance of success, but he is without an adequate tool to handle problems involving two or more intersections. By programming computers to simulate actual traffic conditions at a series of intersections, the means for predicting traffic flow and anticipating congestions could be analyzed before the field trial.

Prof. Goode listed the steps needed in the creation of the computational tool, as follows:

1. Development of a "reasonable" mathematical model of a single intersection, programming of the model for a digital computer, and subsequent runs on a computer to test it for consistency.

2. Development of a 4-intersection model to introduce the first complications of multiple intersections, programming and subsequent running on a digital computer to check out its consistency.

3. The creation of a more complex and perhaps more realistic model still with four intersections but with a multiplicity of lanes, varied types of traffic, etc., as complications.

4. The design of an experiment in connection with real traffic to measure the parameters governing some specific traffic situation.

5. The comparison of the results of this experiment with similar efforts applied to a computer model.

6. If the experimental results do not agree with those of the computer model, the necessary modifications to the computer model and repetition of experiment until a check is obtained.

7. A change in the computer model with a consequent prediction of outcome for real traffic.

8. An experiment to test the validity of the prediction.

With the accomplishment of these steps, a useful version of a computational tool for traffic engineering will have evolved. Steps 1 and 2 have been completed by Prof. Goode and a test is presently being conducted by others in Washington, D. C., to fulfill step 4. Lack of financial support has limited further studies by Prof. Goode.

The talk was illustrated with slides and a particularly interesting film showing the computer oscilloscopic output with moving cars represented as blips. Four intersections were shown with 576 cars per hour entering each of the four entrances. Ten per cent of the cars turned right; 10%, left, and the remaining 80% went straight ahead. The light cycle was: green, 25 seconds; amber, 5 seconds; red, 30 seconds.

Prof. Goode proposed that, after the simulation steps have been completed, and reliable predictions obtained, state highway departments could make computer facilities available for solution of traffic problems in the smaller towns. Many of the larger cities would find it profitable to use their own computers. Although this type of simulation is not the final answer to traffic control, it is extremely useful for analyzing proposed control schemes at minimum cost and without dented fenders.

Prof. Goode has been director of the systems analysis and simulation department of the Willow Run Research Center, head of the Electronic Defense Group, professor of electrical engineering, and professor of industrial engineering. He also has been a member of a number of important national committees, including the Air Force Committee on Advanced Reconnaissance, the Reliability Committee of the House of Representatives Appropriation Committee, the Advisory Panel on Ordnance, Transport, and Supply to the Assistant Secretary of Defense, and the Computer Committee of the Society of Automotive Engineers. Prof. Goode was vice-chairman of the National Joint Computer Committee for 1958 and is chairman of that committee for 1959.

Another feature of the meeting was the presentation of a Fellow Award plaque to Dean J. S. Johnson, professor of electrical engineering and dean of the College of Engineering of Wayne State University, Detroit, Mich. Prof. J. A. M. Lyon of the University of Michigan made the presentation.

A PLAQUE denoting his transfer to the grade of Fellow in the AIEE was presented to J. S. Johnson (*left*), professor of electrical engineering and dean of the College of Engineering at Wayne State University, at the January meeting of the Michigan Section, AIEE, by Prof. J. A. M. Lyon (*right*) of the department of electrical engineering, University of Michigan.

Seven Areas of Atomic Interest Will be Covered by Nuclear Congress

A STREAMLINED PROGRAM, covering seven major areas of interest in the atomic field, is offered for the 1960 Nuclear Congress to be held at New York City's Coliseum, April 4-7, 1960. (See p. 21A).

All of the 57 technical papers to be presented were specifically solicited to cover nuclear production problems which the program committee, headed by E. B. Gunyou, felt needed more clarification and study.

Brookhaven Photo

Clarke Williams
General Chairman

Alco Photo

E. B. Gunyou
Program Chairman

Most attention is being paid to the reactor problems. A total of 17 papers will be presented at four sessions devoted to reactors. One other session will cover reactor design with 4 papers.

Three sessions on environment problems will offer 12 papers; and two sessions on materials and components, 9 papers. Four papers each at one session will be devoted to nuclear standards, isotopes, and radiation processing. Three papers are scheduled for the opening session.

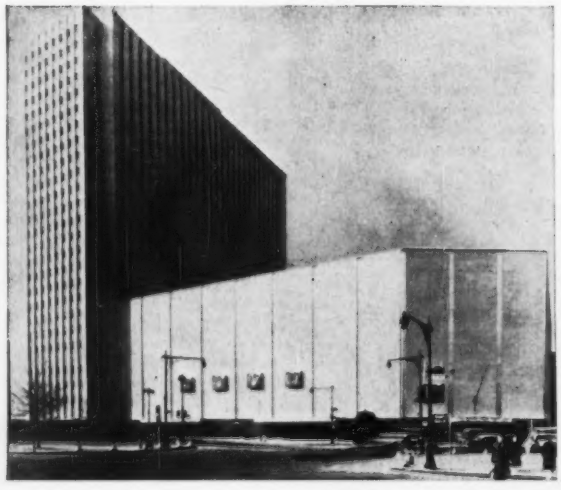
The 6th International Atomic Exposition will be held in conjunction with the Congress at the Coliseum. Also co-ordinated with the Congress program will be sessions of the 8th Atomic Energy in Industry Conference, sponsored by the National Industrial Conference Board, and sessions of the Society of Automotive Engineers, on nuclear propulsion in aircraft. The latter sessions will be held elsewhere in the city during the week the Nuclear Congress is in session.

The Congress, sponsored by Engineers Joint Council, Inc. (EJC), is supported by 28 engineering, scientific, and industrial organizations. AIEE is a participating society. The 1960 Nuclear Congress is being managed by the American Society of Civil Engineers.

A general All-Congress session will open the 1960 event at 9:30 a.m., Monday, April 4. The theme of the opening session will be: "What Will the Future Development of Nuclear Energy Demand from Engineers?" The three papers to be presented at the general meeting cover the subjects of outer space and the role of the nuclear engineer, fuel utilization in future atomic power plants, and engineering requirements of the future.

The meeting will be highlighted by an All-Congress banquet on Wednesday night, April 6, in the Grand Ballroom of the Hotel Statler Hilton, in which all organizations holding events during the week will participate. The Statler Hilton also will serve as the headquarters hotel for the Congress.

Clarke Williams, chairman of the nuclear engineering department of the Brookhaven National Laboratory, Upton, N. Y., is general chairman of the Congress, and also heads its operating committee.



THE NEW YORK COLISEUM *(left)* at Columbus Circle will house the Engineers Joint Council's 1960 Nuclear Congress, April 4-7. AIEE is included among the sponsors of the Congress.

Objectives

The Nuclear Congress was established in 1955 and has been produced annually since that year. The objectives are:

1. To provide free exchange of knowledge in the subject area between engineers and scientists and the industry which is dependent upon such information.
2. To offer consolidation of facility for such exchange of knowledge, which will reduce the demands on the time and expense of individuals and organizations.
3. To facilitate participation by all organizations who find benefits for their membership through such co-operative endeavor.
4. To establish a pattern of co-operation among the organizations participating which may influence other areas of professional and scientific endeavor.
5. To create favorable public recognition for those participating in the development of nuclear energy, as a public service, for the benefit of mankind.

The Congress offers an exceptional opportunity for accumulating up-to-the-minute information and for expanding personal contacts in the nuclear industry.

All papers on the conference program are being printed separately, in pocket-sized booklets. Single copies or bulk supplies are available on request at 50¢ per copy. Additional copies may be purchased at the Congress. Deliveries of copies will be made immediately following the dates of the Congress.

The headquarters for Congress housing and for social events is the Statler Hilton Hotel, located on 7th Ave. at 33rd St., opposite Pennsylvania Station. This hotel is connected directly with the Coliseum by subway. Reservations will be made in order of requests, to the capacity of the hotel. Mention the Congress in your request to the hotel. Late requests will be assigned to other hotels through the co-operation of the New York Convention and Visitors Bureau.

Registration

While the 28 participating organizations are giving special encouragement to attendance by their members, there is no membership limitation on attendance or participation. Advance registration is encouraged.

Registration for the Congress will be conducted at the Coliseum, April 4-6. Advance registration may be made, addressed to the Congress office, 29 W. 39th St., New York 18, N. Y. The registration fee is $15 per person. Members of the National Industrial Conference may register for the Nuclear Congress and will be billed by the National Industrial Conference Board for both.

Consolidation of all press facilities at the Coliseum has been provided as a convenience for the working press. Complete information and materials will be available at all times during the Congress. Prior to the dates of the Congress, inquiries should be addressed to the Public Relations Manager, Nuclear Congress, 29 W. 39th St., New York 18, N.Y.

Because of the number of committees which will be meeting during the Congress, it is impossible to give an accurate listing of dates, places, and committee names. All involved in committee meetings should obtain full data on dates, places, and committee names from their committee secretaries.

An outstanding feature of the Congress is the trade show and exposition which will occupy the exhibit area of the Coliseum. This Atomic Exposition will be open each day, Monday, April 4, through Thursday, April 7, from 9:00 a.m. to 5:00 p.m., except Monday, when the gates will open at 11:00 a.m. The time for the Congress sessions has been arranged to encourage careful study of all the industrial exhibits. Registration for the Congress includes admission to the Exposition.

Authors' Breakfasts

Each day of the Congress, all speakers, presiding officers, discussors, and program officials will assemble for a breakfast briefing session. The hour will be from 8:00 a.m. to 9:00 a.m., and the place, the tower room on the second mezzanine of the Coliseum. Presiding will be Dr. E. B. Gunyou, program committee chairman.

The 1960 Nuclear Congress Committees comprise the following:

General Chairman: Clarke Williams

EJC Nuclear Congress Committee: Chairman L. M. Currie, J. R. Dunning, G. E. Halbrook, W. E. Kelley, and C. R. McCullough.

Operating Committee: Chairman Clarke Williams, Vice-Chairman W. H. Wisely, F. J. Van Antwerpen, N. S. Hibshman E. O. Kirkendall, W. H. Wisely, O. B. Schier II, E. P. Lange, John McMahon, E. B. Gunyou, D. P. Reynolds, and J. S. Koss.

Program Committee: Chairman E. B. Gunyou, Vice-Chairman F. D. Acker, D. O. Myatt, F. T. Barr, C. F. Savage Jr., J. E. Harding, Bruce Dunnington, F. B. Elder, Rod Hohl, J. G. Terrill Jr., Fitzgarald Acker, H. H. Hansteen, Roger Sutton, R. J. Faust, F. E. Fuhrman, S. Baron, M. E. Cassiday, J. F. Black, Frances Weeden, F. F. Kravath, and Charles Tilgner Jr.

Staff: D. P. Reynolds, Congress manager, and J. S. Koss, assistant Congress manager.

Tentative Program

All sessions will be conducted on the fourth floor of the Coliseum. The tentative Congress program follows:

Monday, April 4

9:30 a.m. All-Congress Session

Chairman: J. R. Menke, Nuclear Development Corporation of America.

Theme: What Will Future Development of Nuclear Energy Demand from Engineers?

Outer Space Exploration and the Nuclear Engineer. *John Simpson*, Westinghouse Electric Corp.

Fuel Utilization in Future Atomic Power Plants. *W. H. Zinn*, Combustion Engineering Inc.

Engineering Requirements for the Future. *W. K. Davis*, Bechtel Corp.

2:00 p.m. Afternoon Sessions

Materials and Components—Session I
Metal, Ceramic, Organic Materials

Chairman: B. W. Dunnington, Battelle Memorial Institute.

Effect of Irradiation on Tensile Properties of High-Temperature Steel and Nonferrous Alloys. *Sam Bartz*, Phillips Petroleum.

Experience in Use of Organic Coolant in Nuclear Reactors. *S. C. Spencer, W. N. Bley, R. W. Burkhardt, G. O. Haroldsen*, Atomics International.

Problems in Contamination of Water-Cooled Reactors Using Stainless Steel Components. *Dennis Foley*, Alco Inc.

U. S. Bureau of Mines Research on the Fused Salt Electrorefining of Beryllium. *D. H. Baker Jr., M. M. Wong, R. E. Campbell*, Boulder City, Nev.

Preparation of High Purity Theorium by Reduction with Sodium. *F. E. Block, P. C. Good*, U. S. Bureau of Mines.

Environment—Session I
Plant Construction and Site Location

Chairman: J. C. Callahan, Morris-Knowles Inc.

Vice-Chairman: W. C. Siler, Jackson and Moreland Inc.

Results of 1959 Nuclear Power Containment Tests. *Alf Kolflat*, Sargent and Lundy.

Review of Shippingport Operations—Site Factors. *J. E. Gray*, Duquesne Light Co.

The N. S. *Savannah*—Progress Report. *P. P. Eddy, K. W. Hess*, Nuclear Projects Office, General Atomics Organization.

Civil Engineering Aspects of Nuclear Power Plants. *R. W. Kupp, J. C. Tourek*, Vitro Engineering Co.

Reactor—Session I
U. S. Power Reactors

Chairman: Sidney Baron, Burns and Roe Inc.

The Army Nuclear Power Program. *Donald G. Williams*, Army Nuclear Power Program.

Budocks Role in the Development of Nuclear Power for the Navy's Shore Bases. *W. J. Christensen*, Budocks, Department of the Navy.

Reactor Development in the Next 10 Years. *Frank Pittman*, U. S. Atomic Energy Commission (AEC).

Sites for Nuclear Power Plants for Large Spanish Utility. *Jamie MacVeigh*, Tecnatom.

Tuesday, April 5

9:30 a.m. Morning Sessions

Environment—Session II
State—Federal Regulations Protecting Public Health

Chairman: Merrill Eisenbud, New York University

Status of Regulation at the Municipal Level. *Hanson Blatz*, New York City health department.

Status of Regulation on the State Level. *Oliver Townsend*, New York State Office of Atomic Development.

Status of Regulation on Federal Level: Responsibilities of the U. S. Public Health. *F. J. Weber*, Department of Health, Education, and Welfare.

Status of Regulation on International Level. *A. I. Galagan*, International Atomic Energy Administration, United Nations.

Materials and Components—Session II
Fuel Technology

Chairman: L. M. Currie, Babcock and Wilcox Co.

Ignition and Detonation of Uranium in Bromine Trifluoride Solutions. *R. Johnson, F. Horn, G. Strickland*, Brookhaven National Laboratories.

Uranium-Thorium Reprocessing: Cost Outlook for Commercial Operation. *R. J. Klotzbach.*

Low Impurity Core Materials. *G. Pancer, J. L. Zegger*, Alco Products.

Status of the Plutonium Recycle at Hanford. *R. E. Dunn*, Hanford Atomics Products, General Electric Co.

Reactor—Session II
Research Reactors and Radiation Facilities

Chairman: Hugh Neale, AMF Corp.

Operation and Experimental Use of the Battelle Research Reactor. *A. M. Plummer, J. N. Anno, J. W. Chastain Jr.*, Battelle Memorial Institute.

Operating Experience with In-Pipe Loops at ORNL. *J. A. Cox*, ORNL.

Construction and Operation of the McMaster Nuclear Reactor. *W. H. Fleming*, McMaster University.

The Design of a Hot Laboratory for Metallurgical Research in Germany. *W. Stephan*, GFKF Institute Fur Reaktorwerkstoffe.

2:00 p.m. Afternoon Sessions

Reactor—Session III
Progress in Reactor Instrumentation

Chairman: H. A. Lamonds, North Carolina State College

Vice-Chairman: E. E. Lynch, General Electric Co.

Application of Instrumentation Control. *Walter Lapinski*, Argonne National Laboratory.

Basic Requirements of Instrumentation and Control for Closed-Cycle Water Nuclear Power Plants. *C. F. Obermesser*, Westinghouse Electric Corp.

Control and Instrumentation Equipment—In-Core. *H. M. Ogle, J. Forster, H. H. Hendon, J. H. Keeler*, General Electric Co.

Control and Instrumentation Equipment—External. *E. P. Epler*, ORNL.

Status of Present State of Technology Instrumentation and Control Systems for Nuclear Power Reactors. *F. C. Legler, H. E. Vann*, U. S. AEC.

Environment—Session III
Water Supply and Waste Disposal

Chairman: E. S. Cole, Pitometer Associates

Vice-Chairman: R. E. Fuhrman, Water Pollution Control Federation

A 2-Year Study of Environmental Radioactivity Levels Prior to Nuclear Power Plant Operation. *J. V. Nehemias*, Radiological Health Surveys of National Sanitation Foundation, University of Michigan.

Strontium 90 in Surface Water. *C. P. Straub, L. R. Setter, P. F. Hallbach, A. S. Goldin*, Department of Health, Education, and Welfare, Robert A. Taft Sanitary Engineering Center.

Low-Level Tritium Measurement with the Liquid Scintillation Spectrometer. *W. J. Kaufman, R. M. Hours*, University of California.

Radioisotopes in a Municipal Water System Near the Hanford Atomic Products Operation. *R. L. Junkins*, General Electric Co.

Nuclear Standards Session

Chairman: F. L. LaQue, Development and Research, International Nickel Co.

Vice-Chairman: K. A. Kesselring, DIG Project, Knolls Atomic Power Laboratory

Senior representatives of each of four specification and code-writing organizations interested in nuclear standards will present discussion of the interests, aims, and methods of their organization in furthering the development of satisfactory standards for the nuclear industry.

American Society for Testing Materials—*N. L. Mochel,* Westinghouse Electric Corp.

American Nuclear Society Standards Committee—*C. R. McCullough,* U. S. AEC.

American Society of Mechanical Engineers, Committee on Nuclear Power of the Boiler and Pressure Vessel—*D. A. Rohers,* Allied Chemical and Dye Corp.

Standardization of the Procedure to Qualify Materials for Nuclear Piping Systems. *J. A. Klapper,* Ebasco Services Inc.

Wednesday, April 6

9:30 a.m. Morning Sessions

Reactor—Session IV
Advanced Reactors and Fuel Cycles

Chairman: L. J. Everett, Philadelphia Electric Co.

Advanced Water Cooled Reactors. *W. E. Shoupp, J. H. Wright,* Westinghouse Electric Corp.

Army Gas Cooled Reactors. *M. A. Rosen, G. A. Bicher,* U. S. AEC.

High Temperature, Gas Cooled, Graphite-Moderated Reactor. *David Rose,* John J. Hopkins Laboratory, General Dynamics Corp.

Nuclear Superheater Designs and Fuel Cycles. *E. L. Zebroski, K. M. Horst, P. G. Aline,* General Electric Co.

Isotope Application

Chairman: F. T. Barr, Esso Research and Engineering Company

Industrial Radioisotope Applications Development Sponsored by U. S. AEC. *P. G. Aebersold,* Office of Isotopes Development, U. S. AEC.

Applications of Nuclear Science in the Producing Branch of the Petroleum Industry. *Milton Williams,* Humble Oil and Refining Co.

Field Techniques and Instrumentation for Radioactive Gas Tracers. *F. E. Armstrong,* U. S. Bureau of Mines.

Isotopic Power. *J. G. Mores,* Martin Co.

2:00 p.m. Afternoon Sessions

Radiation Processing Session

Chairman: Don Brunton, Curtiss-Wright Corp., Princeton Division

Vice-Chairman: M. M. Markels

Progress and Problems in Radiation Processing of Foods. *Walter Urbain,* Swift and Co.

Commercialization Technology and Economics in Radiation Processing. *H. F. Kraybill, D. C. Brunton,* Curtiss-Wright Corp.

Radiation Technology for Nonbiological Materials. *A. J. Restaino,* Atlas Powder Co., Industrial Reactor Laboratory.

Current Aspects of the Wholesomeness of Irradiated Foods. *Merril Read,* Fitzsimmons General Army Hospital.

Reactor Design Engineering Session

Chairman: Joe Gallagher, Alco Products, Inc.

Determination of Pressure in a 2-Phase Water System. *W. H. Comtois,* Combustion.

Hydraulic Instability of Reactor Parallel Plate Fuel Assemblies. *E. B. Johansson,* KAPL.

Natural Convection Flow in Liquid Metal Mobile Fuel Nuclear Reactors. *F. G. Hammitt, E. M. Brower,* University of Michigan.

A Method for the Economic Comparison of the Th-U-235 Fuel Cycle Versus the U-238-U-235 Fuel Cycle with Application to the MCCR. *R. T. Sahnstrom,* General Atomic.

All-Congress Banquet

With the co-operation and support of all participating organizations, a general banquet and reception will be held Wednesday, April 6, in the Grand Ballroom of the Statler Hilton Hotel. Preceded by a general assembly and cocktail hour, the banquet will be the major social gathering of the Congress.

For this event, special tables may be reserved, each seating 10 persons. Complete tables or partial tables may be reserved. Requests should be forwarded to the 1960 Nuclear Congress Management, 29 W. 39th St., New York 18, N. Y., accompanied by a check or request for billing. The published seating list will close at 2:00 p.m. on Tuesday, April 5. Tickets purchased after that hour will be assigned to tables in order of purchase, up to the capacity of the ballroom. Wives are welcome. Business dress will be acceptable. The cost will be $10 per plate.

LOOK what two out of five have done.* Don't be a sidewalk superintendent. Lend a hand!

*22,000 out of 55,000 AIEE Members have contributed 90.4% of our quota for the new United Engineering Center.

U. S. Group Completes Plans for Participation in WPC in Spain

UNITED STATES representatives have submitted 13 technical papers relating to methods of solving power shortage problems for the 13th biennial sectional meeting of the World Power Conference (WPC) to be held in Madrid, Spain, June 5-9, 1960.

The papers were sponsored by the U. S. National Committee, which held its annual meeting in Washington, D. C., January 19. The United States group is one of 55 National Committees from all over the world making up the membership in the WPC, a nongovernment international organization with headquarters in London, England. In addition to the biennial sectional meetings, plenary sessions are held once every 6 years.

Using the subject "Method of Solving Power Shortage Problems," the general theme of the Madrid conference will stress the long-term rather than short-term supply of a country's energy needs.

Conference Subjects

The list of subjects which will be covered at the conference follows:

1. *Methods of investigation of energy sources and requirements*. This will be concerned with energy sources (solid fuels, liquid fuels, gaseous fuels, hydraulic energy, nuclear energy, and other sources of energy) and energy requirements.

2. *Efficiency of production and utilization of energy*. This will include conventional fuels, hydraulic energy, and other sources of energy.

3. *Technical development in transportation*. Conventional fuels, electric energy, and nuclear fuels will be discussed in this section.

4. *Establishment of nuclear reactors on an industrial scale*. The fields of application discussed here will be: electric power generation, propulsion (marine, and other fields), and generation of heat for industrial and domestic users. Economic and social factors considered will be: economy in reactor construction, training of personnel, safety measures and insurance, and other factors.

5. *Functional interrelation between conventional and nuclear production of energy*. The types of electric power discussed here will be: conventional resources, base load operation of nuclear power plants, transmission of energy, storage of energy, and other factors. Other applications also will be studied.

13 Technical Papers

At the January 19 meeting, the U. S. National Committee announced that the 13 technical papers submitted by its representatives cover the entire range of subdivisions of the conference theme. A list of these papers and their authors follows:

Methods of Evaluating Sources and Requirements for Solid and Liquid Fuels in the United States. *C. C. Anderson, T. W. Hunter*, Bureau of Mines, U. S. Department of the Interior

Methods of Investigating Hydroelectric Energy Potential on Multiple-Purpose Reclamation Projects. *F. E. Dominy*, Bureau of Reclamation, U. S. Department of the Interior

Forecasting Electric Power Requirements and Generating Facilities. *A. S. Griswold, F. D. Campbell*, The Detroit Edison Co.

Thirty Years of Development in Improving Efficiency and Reducing Costs of Thermoelectric Generation of Electric Energy. *Philip Sporn, S. N. Fiala*, American Electric Power Service Corp.

Operations Research Study of Peaking Power Economics. *J. K. Dillard*, Westinghouse Electric Corp.

Passamaquoddy—Harnessing Tidal Power for Energy. *J. W. Leslie*, U. S. Corps of Engineers

Transportation and Storage of Gaseous Fuels. *K. B. Nagler*, The Peoples Gas Light and Coke Co.

The Development of Commercially Practical Nuclear Power Reactors. *W. L. Cisler*, The Detroit Edison Co.

Technological and Economic Factors Affecting the Rate of Development of Nuclear Power in the United States. *E. T. Hughes, N. C. Nelson*, Federal Power Commission

EHV Systems in the Progress of the Electric Utility Industry of the United States. *P. A. Abetti, I. B. Johnson*, General Electric Co.

Nuclear Power Application other than Central Station Power. *F. E. Pittman*, U. S. Atomic Energy Commission

Nuclear Fuel Resources and Reactor Fuel Costs. *W. H. Zinn*, Combustion Engineering Inc.; *J. R. Dietrich*, General Nuclear Engineering Corp.

Base Load Nuclear Power Plants in an Integrated Hydroelectric and Thermal Electric Power System. *C. C. Whelchel*, Pacific Gas and Electric Co.

U. S. Committee

The U. S. Committee, which is managed by an executive board of nine members, also announced the election of its officers to serve for the ensuing year. They are: F. L. Adams, chief, Bureau of Power, Federal Power Commission, as chairman; J. N. Landis, vice-president, Power Division, Bechtel Corporation, as vice-chairman; and Brig. Gen. S. E. Reimel, U. S. Army (retired), as secretary.

The technical papers will be printed and distributed to each registrant several months in advance of the Madrid conference date, so that the session may be conducted on a discussion, or workshop, basis rather than with formal presentations of the complete papers. There also will be postconference tours including visits to power installations, industrial plants, and points of interest throughout Spain.

All participants in meetings of the WPC must register through their National Committees. U. S. participants should write to the U. S. National Committee for registration forms, which must be returned to the secretary with the $50 registration fee.

The secretariat for the U. S. Committee is furnished through the Engineers Joint Council, 29 W. 39th St., New York 18, N. Y. All communications should be directed to: The Secretary, U. S. National Committee, World Power Conference, at that address.

The U. S. Committee is composed of three major groups of participating members. They are: (1) the professional engineering societies, including AIEE; (2) the industrial, utility, or similar associations; and (3) the federal and state government bodies.

The technical sessions of the Madrid sectional meeting will be held in the Instituto Nacional de Industria, Plaza de Salamanca 8. There will be 7 technical sessions totaling some 25 working hours. In addition to the postconference tours, the Spanish Committee also has made plans for a number of social events. The U. S. Committee has made arrangements with Thomas Cook and Sons to serve as its official travel agent.

Further information may be obtained from: F. L. Adams, chief, Bureau of Power, Federal Power Commission, Washington, D. C.; and Brig. Gen. S. E. Reimel, World Power Conference, 29 W. 39th St., New York 18, N. Y.

The emblem adopted for the meeting is composed of the sun of Spain and the windmills of Don Quixote. These are two power motives, one natural and primary, the other highly evocative, and both typical of Spain. The sun, source of life and power, is an essential element of the Spanish scene, brightening its fields and cities and bringing men and women to the peninsula from all over the world.

The working languages at this Madrid sectional meeting are English, French, and Spanish. As soon as the technical papers received before the closing date have been accepted by the Spanish National Committee, they will be printed as separate pamphlets in the working languages in which they have been written, together with a summary in each of the three languages. The general reports will be printed in all three languages.

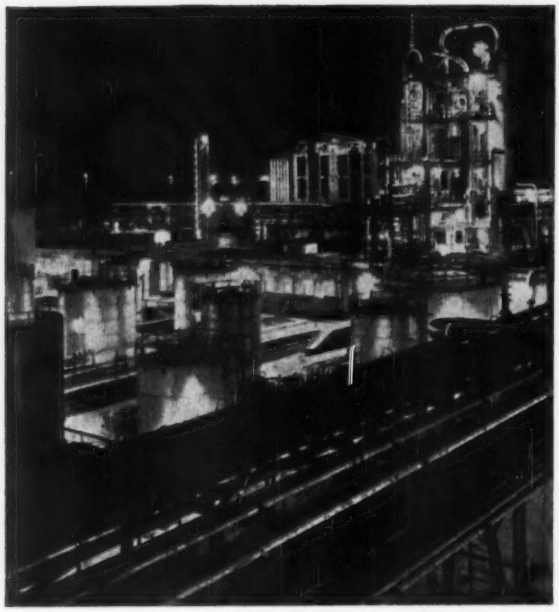
Visits in the Area

Technical visits will be made to the following places:

Barajas Factory, Empresta Nacional de Autocamiones, S. A. This company builds motor lorries, tractors, diesel engines, and other component parts for transport vehicles. Its output capacity is 6,000 vehicles per annum and 3,000 sets of injector and electric equipment. It is associated with the well-known British firm, Leyland Motors.

Villaverde Transformer Substation of Hidroeléctrica Española, S. A. This is the main junction of the various lines that supply Madrid with electricity. The Villaverde substation has 44 outgoing lines at voltages of 220, 138, 50, and 15 kv; 960 mva rated transformer capacity, and 180 kvar in synchronous power-factor correctors, making it one of the biggest and most modern installations of its kind in Spain. The plant is at present in the process of being enlarged.

The "Juan Vigón" Centre, Nuclear Energy Board. This Centre comprises sections for physics, chemistry, materials, metallurgy, and reactors. Especially important are two pilot plants, one for chemical research on an industrial scale and the other connected with the production of metallic uranium and the construction of fuel elements. Finally, a 3-thermal-mw experimental swimming-pool type reactor is used



DURING the World Power Conference in Spain, a tour of the Southern Zone will be held Friday, June 10. Participants will leave Madrid by motor coach at 8:30 a.m., have lunch at Puertollano, and visit the Calvo Sotelo Company's works (left).

Pando Photo

for research and also for obtaining medium and short-lived isotopes.

Technical Institute of Construction and Cement. A noncommercial Institute engaged in technical research on building methods and the manufacture of materials. Its well-known studies include interesting tests on modern special structures. The Institute has one experimental factory and other plants for semi-industrial tests with cement, plaster, and ceramic materials. It is also the headquarters of the Spanish Association of Soil Mechanics and Prestressed Concrete. The Institute forms part of the "Patronato Juan de la Cierva," one of the many sections of the Higher Council for Scientific Research. This all-embracing organization dependent on the Ministry of Education was founded in 1939 to promote, guide, and co-ordinate scientific research in Spain.

Standard Eléctrica, S. A. This factory for telephone and radio material is associated with the International Telephone and Telegraph Corporation. As well as automatic and manual telephone-switching systems, telephone repeaters and auxiliary material, it manufactures other communication systems, such as multichannel radio links and high-frequency carrier current equipment on coaxial cables. The Madrid factory employs 6,000 workers. The same company has another factory in Santander, which specializes in telephone cables. A considerable part of the output of both is exported.

Isodel Sprecher, S. A. Here is manufactured electric equipment, notably small oil-volume automatic switches up to a voltage of 150 and 220 kv, medium-and high-voltage sectionalizers, high-power circuit breakers, measure transformers, and lightning arresters.

Entrepeñas and Buendia Reservoirs and Power Plant. These large reservoirs, linked by a tunnel 3 miles long, form one of the biggest artificial lakes in Europe. They have been constructed by the State to control the flow of the River Tagus as part of a vast irrigation plan for the lower part of the basin of this river. The hydroelectric power stations at the foot of both dams have been erected by a private concern, the Unión Eléctrica Madrileña, S. A., one of the oldest-established electric utility companies in the capital.

San Juan and Picades Hydroelectric Power System. A large combined irrigation and power scheme for harnessing the hydraulic resources of the mountainous basin of the River Alberche. The power stations belong to the Unión Eléctrica Madrileña, S. A.

Excursions will be made to Toledo, Segovia, and El Escorial.

Study-Tours

Six study-tours have been planned. A short synopsis of the itineraries for the study-tours follows:

Northwest. Through the old cities of the Castilian tableland, Avila and Salamanca, with their medieval or Renaissance lines, to the Galician region with its lovely scenery and its hydroelectric resources. Here stands Santiago de Compostela, one of the most famous shrines of Christian pilgrimage and a storehouse of art.

North. The first stage of this route passes through the historic cities of Valladolid and Leon—the former with its interesting sculpture museum, the latter with its Cathedral, a jewel of Gothic art—reaching the Asturian region and then continuing along the beautiful Cantabrian coast as far as the Basque country. In this district the largest and most important industrial area of Spain is to be found, with coal mines, busy firths, and modern town. Near the new iron and steel works at Avilés is Covadonga, whence the Spaniards started out on the 8-century Reconquest from the Moors. Later, in Santander Province, there is Santillana, the town of old ancestral mansions. Further on lies Bilbao, the famous iron-working city, and finally, almost on the French frontier, the pretty watering place of San Sebastián.

Northeast. This route passes through the natural park known as the "Monasterio de Piedra" and the historic city of Saragossa; then, by the Arán Valley, it reaches the Pyrenean heights with their large hydroelectric works. The route takes in Barcelona, one of the largest ports on the Mediterranean, where history, trade, and industry are combined. The visit to Barcelona will coincide with the International Samples Fair there.

East. This route includes a visit to the petroleum refinery works beside the natural harbor of Cartagena—famous since the days of the Carthaginians—and the iron and steel works at Sagunto. It passes through the richest citrus district of Spain, and concludes with the delightful trip to Majorca, one of the world's most famous beauty spots.

South. This itinerary leads to the "Sun Coast," after passing through towns, such as Cordova, which today have important industrial installations and in old times were the wonder of the west. Cordova, the ancient capital of Moslem Spain, which led the world in science and learning, still preserves its peerless Mosque. Granada, the last independent Arab city in Spain, offers its marvelous combination of architecture and scenery. Malaga throws open its harbor to the Mediterranean sunlight.

Southeast. This route starts by the Extremadura Road, and its first stages provide a panorama of the vast land-settlement scheme in progress under the title of the "Badajoz Plan." Later, through the mansions and garden of Cáceres and the Roman Forum and Theatre at Mérida, it leads to Seville and Cádiz, cities of art and history going back thousands of years, with modern activities in river-borne trade or shipbuilding, beneath the luminous Andalusian sky.

The 50 countries represented at the WPC are as follows. Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Ceylon, Chile, Colombia, Costa Rica, Cuba, Czechoslovakia, Denmark, Finland, France, Germany, Ghana, Great Britain, Greece, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Luxembourg, Malaya, Mexico, Morocco, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Paraguay, Peru, Philippines, Poland, Portugal, Rhodesia and Nyasaland, Roumania, Spain, Sweden, Switzerland, Thailand, Trinidad, Turkey, Uganda, Union of South Africa, United Arab Republic, Uruguay, United States, Union of Soviet Socialist Republics, Venezuela, and Yugoslavia.

SUPPORT THE NEW UNITED ENGINEERING CENTER

Central Studios

FAMOUS for its beach and boardwalk, Atlantic City *(above, left)* was selected as the host city for the AIEE 1960 Summer General Meeting. The Chalfonte-Haddon Hall Hotels *(background)* will be headquarters for the meeting. The new all-weather swimming pool *(above, right)* is located within the hotels. The best in meeting and recreational facilities are combined in the choice of the convention site.

Host City Selected for Summer General Meeting

Atlantic City, N.J., the convention city built entirely on sand along 5 miles of beach and boardwalk, has been chosen as the host city for the AIEE 1960 Summer General Meeting, which will be held June 19-24.

Headquarters will be at the Chalfonte-Haddon Hall Hotels on the boardwalk. The AIEE Philadelphia Section will act as hosts for this meeting.

The Summer General Meeting, in addition to its technical aspects, can afford the opportunity for a pleasant vacation; hence, the selection of Atlantic City as this year's meeting site.

The whole family is invited to this meeting at the "World's Playground." There will be a full program of interesting social and sporting events for everyone. Sports activities will include golf and deep sea fishing.

Nominees Selected for 1960-61 Terms of Office

AIEE officers for terms beginning August 1, 1960, were nominated February 1, 1960, during the Winter General Meeting at the Statler Hilton Hotel in New York, N. Y.

For President:

C. H. Linder, vice-president—Engineering Services, General Electric Company, New York, N. Y.

For Vice-Presidents:

C. E. Gaylord, engineer, New York Telephone Company, Buffalo, N. Y. (District 1)

R. T. Weil, Jr., professor and head, electrical engineering department, Manhattan College, New York, N. Y. (District 3)

F. W. Bush, assistant to vice-president, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. (District 5)

S. C. Wright, outside plant engineer, Southwest Bell Telephone Company, Oklahoma City, Okla. (District 7)

H. A. Carlberg, plant engineering manager—Hanford Works, General Electric Company, Richland, Wash. (District 9)

A. W. Rauth, general meter and laboratory superintendent, Consumers Power Company, Jackson, Mich. (District 11)

Walter Criley, electrical engineering professor, Vanderbilt University, Nashville, Tenn. (District 13)

P. G. Wallace, assistant chief engineer, Texas Power & Light Company, Dallas, Texas (District 15)*

For Directors:

R. B. Gear, director of purchases, Commonwealth Edison Company, Chicago, Ill.

C. T. Hatcher, division engineer, Cable Division, Consolidated Edison Company of New York, Inc., New York, N. Y.

C. T. Pearce, engineering and service manager of Atlantic Region, Westinghouse Electric Corporation, Philadelphia, Pa.

For Treasurer:

W. R. Clark, assistant engineer, production engineering, Leeds & Northrup Company, Philadelphia, Pa.

The Nominating Committee, in accordance with the Constitution and Bylaws, consists of one representative of each geographical District, one representative of each Technical Division, and other members chosen by and from the Board of Directors not exceeding in number the number of Technical Divisions.

The Constitution and Bylaws of the Institute require publication in *Electrical Engineering* of the nominations made by the Nominating Committee. Provision is made for independent nominations as indicated in the following excerpts from the Constitution and Bylaws:

Constitution: C33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws: B28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C33 (Constitution) must be received by the Secretary of the Nominating Committee not later than March 15 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the Nominating Committee in accordance with the Constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

The duties of the Nominating Committee are defined in the Constitution and Bylaws (Organization Manual pp. 146, 152-53) and *Electrical Engineering* of November 1959, pp. 1130-31. C50.010-C50.060 of the Constitution covers the eligibility and terms of officers. C70.010-C70.060 describes their duties.

*Effective August 1, 1960, District 7 will be divided into two Districts, namely Mid-America District 7 and Southwest District 15. Mr. Wallace was nominated by District 7 to be vice-president of District 15.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

American Power Conference To Hold 22nd Annual Meeting, March 29-31, 1960

ALL ASPECTS of the power industry will be discussed at the 22nd annual meeting of the American Power Conference (APC) which will be held March 29-31, 1960, at the Sherman Hotel in Chicago, Ill.

The 3-day meeting will include some 95 papers and addresses. A highlight of the technical program will be an evening forum devoted to unconventional methods of generating power. Included will be a discussion of magnetohydrodynamics, isotopic heat and power, the fuel cell, and the nuclear rocket program.

The Illinois Institute of Technology is directing the conference. Co-operating societies are the following: AIEE; American Institute of Chemical Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Civil Engineers; American Society of Heating and Air Conditioning Engineers; American Society of Mechanical Engineers (ASME); National Association of Power Engineers; Western Society of Engineers (WSE); and Engineers' Society of Milwaukee.

Co-operating universities are as follows: Iowa State College, Michigan State University, Northwestern University, Purdue University, State University of Iowa, University of Illinois, University of Michigan, University of Minnesota, and University of Wisconsin. Regional associated universities are: Agricultural and Mechanical College of Texas, California Institute of Technology, Georgia Institute of Technology, Massachusetts Institute of Technology, and New York University.

Further information concerning the conference and a copy of the advance program may be obtained from: Director, American Power Conference, Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

The tentative program for the conference follows:

Tuesday, March 29

9:00 a.m. Registration—Mezzanine Floor

10:00 a.m. Opening Meeting—Grand Ballroom

Invocation

The Morality of the Profit System. *John Conrad*, S & C Electric Co.

12:15 p.m. Joint APC-ASME Luncheon—Bernard Shaw Room

Sponsored by the ASME

Chairman: S. P. Kezios, Chicago Section, ASME

Co-Chairman: A. A. Fejer, Illinois Institute of Technology

Speaker: Walker Cisler, president, ASME

Subject: An American Engineer in Russia

2:00 p.m. Afternoon Sessions

Steam Generators—Grand Ballroom

Turbine Generators—Louis XVI Room

Chairman: W. A. Lewis, Illinois Institute of Technology

Co-Chairman: F. M. Scott, Allis-Chalmers Manufacturing Co.

Operating Experience with Conductor-Cooled Turbine-Generators. *L. M. Abrahamson*, Wisconsin Power and Light Co.; *L. T. Rosenberg*, Allis-Chalmers Manufacturing Co.

Four Years Operating Experience with Large Liquid Cooled Turbine-Generators. *C. E. Kilbourne, C. H. Holley*, General Electric Co.

Operating Experience with Inner Cooled Turbine-Generators. *O. K. Brown*, Niagara Mohawk Power Corp.; *J. W. Batchelor*, Westinghouse Electric Corp.

Water Technology I—Advances in Evaporation Techniques—Assembly Room

Space Heating—Crystal Room

Chairman: D. H. Madsen, State University of Iowa

Co-Chairman: Lois Graham, Illinois Institute of Technology

Solar Energy for Future Heat Pumps. *E. B. Penrod*, University of Kentucky; *K. V. Prasanna*, Illinois Institute of Technology

Methods for Evaluating Heat Losses in Concrete Slabs. *M. A. Chaszeyka*, Armour Research Foundation; *S. P. Kezios*, Illinois Institute of Technology

3:30 p.m. Afternoon Sessions

Fuel Cell Tractor and Electric Auto—Crystal Room

Chairman: D. J. Renwick, Michigan State University

The Fuel Cell Tractor. *W. Mitchell Jr.*, Allis-Chalmers Manufacturing Co.

The Electric Auto. *C. R. Erickson*, Board of Water and Light, Lansing, Mich.

Industrial Plants I—Industrial Power Plant Safety—Bal Tabarin Room

Chairman: K. R. Hodges, Sears Roebuck & Co.

Flame Failure Protection for Industrial Boilers. *H. Christiansen*, Electronics Corporation of America

Power Plant Safety. *W. C. Kramer*, Commonmonwealth Edison Company of Indiana

8:00 p.m. General Interest Session—Advanced Engineering Concepts—Grand Ballroom

Magnetohydrodynamic Power. *A. Kantrowitz*, Avco-Everett Research Laboratory

Isotopic Heat and Power. *W. W. T. Crane*, The Martin Company

Nuclear Rocket Program—Where it is and Where it is Going. *H. R. Schmidt*, Division of Reactor Development, Washington, D. C.

Fuel Cells. *Everett Gorin*, Pittsburgh Consolidation Coal Co.

Please mail back your membership survey card promptly.

Wednesday, March 30

9:00 a.m. Morning Sessions

Power Generation for Peak Loads—Grand Ballroom

New Generation Concepts and How They May be Applied. *W. D. Marsh, A. G. Mellor*, General Electric Co.

How Shall We Meet Peaking Requirements? *L. B. LeVesconte, Tor Kolflat*, Sargent & Lundy

Economics of Peaking. *F. A. Ritchings*, Ebasco Services Inc.

The Economics of a 22,000-Kw Peaking Gas Turbine. *J. O. Stephens, B. L. Lloyd*, Westinghouse Electric Corp.

Communications Protection and Control—Louis XVI Room

Chairman: A. A. Casey, Cleveland Electric Illuminating Co.

Co-Chairman: J. W. Nilsson, Iowa State University

Modern Techniques and Methods for Power Line Carrier and Telemetering. *Otto Kries*, Brown Boveri, Ltd.

Remote Control with Data Logging. *W. F. Cruess*, Westinghouse Electric Corp.

Operating Experience with a Microwave System Used with Protective Relaying. *J. L. Harmon*, Cleveland Electric Illuminating Co.

Water Technology II—Analytical Control and Methods—Assembly Room

Distribution and Subtransmission—Crystal Room

Distribution System Planning through Optimized Design. *R. F. Lawrence*, Westinghouse Electric Corp.

Performance and Reliability of 12-Kv vs. 4-Kv Distribution, from the Standpoints of Economics and Protection. *F. G. Josberger*, Long Island Lighting Co.

Hydroelectric Power I—Financing Problems in Hydroelectric Developments I—Bal Tabarin Room

10:30 a.m. Morning Sessions

Switching and Switchgear—Louis XVI Room

Chairman: G. L. Welch, Westinghouse Electric Corp.

Co-Chairman: J. A. Smith, General Electric Co. and chairman, Substations Committee, AIEE

Report on Automatic Grounding Switches. *E. A. Ricker*, Ontario Hydro

Glass Polyester Insulation and Track Resistant Coating—What it is Doing to the Switchgear Field. *R. E. Frink*, Westinghouse Electric Corp.

A New Concept for Switching Subtransmission Circuits. *J. J. Mikos*, S & C Electric Co.

Industrial Electrical—Crystal Room

Sponsored by Industrial Group, Chicago Section, AIEE

Chairman: H. G. Frostick, U. S. Steel Corp.

Co-Chairman: L. L. Quinlan, Inland Steel Co., and chairman, Industrial Group, Chicago Section, AIEE

Ultrasonic Welding in Production. *W. C. Potthoff, William Rosenberg*, Sonobond Corp., Subsidiary of Aeroprojects

Industrial Electrical System-Operation and Maintenance Problems. *C. H. Youngdahl*, United States Steel Corp.

Higher Distribution Voltages in Industrial Plants. *F. Tamberrino, A. Conangla, J. D. Wood*, I-T-E Circuit Breaker Co.

Water Technology III—Ion Exchange—Assembly Room

12:15 p.m.—APC-AIEE Luncheon—Bernard Shaw Room

Sponsored by the AIEE

Chairman: J. H. Foote, president, AIEE

Co-Chairman: Francis Cox, chairman, Chicago Section, AIEE

2:00 p.m. Afternoon Sessions

Large Steam Turbines—Grand Ballroom

Economics of Very Large Turbine-Generators. *J. R. Carlson,* Westinghouse Electric Corp.

Large Steam Turbine-Generators with Spinning Reserve Capacity. *J. E. Downs, E. H. Miller,* General Electric Co.

Factors Influencing the Reliability of Large Steam Turbine Generator Units. *C. D. Wilson,* Allis-Chalmers Manufacturing Co.

High-Voltage Systems—Louis XVI Room

Sponsored by the Power Division of AIEE

Chairman: F. L. Lawton, chairman, Power Division, AIEE

Co-Chairman: F. A. Cox, chairman, Chicago Section, AIEE

Important Technical and Economic Aspects of High-Voltage Transmission. *G. D. Breuer, H. O. Simmons Jr., C. A. Woodrow,* General Electric Co.

EHV Transmission Research at Leadville, Colo. *L. M. Robertson,* Public Service Company of Colorado

A New Method for Predicting Transmission Line Lightning Performance. *C. F. Wagner, A. R. Hileman,* Westinghouse Electric Corp.

Transmission for the New Eddystone Station. *E. B. Shew, A. H. Sellers,* Philadelphia Electric Co.

Water Technology IV—Water Conservation in Industry—Assembly Room

Fuels—Crystal Room

Sponsored by the Fuels Division, ASME

Hydroelectric Power II—Financing Problems in Hydroelectric Developments II—Bal Tabarin Room

Power Rates, Revenues, and Capital Obligations

By a private power company.

By a self-financed public authority.

By a public utility commissioner.

6:30 p.m. All-Engineers Dinner—Grand Ballroom

Thursday, March 31

9:00 a.m. Morning Sessions

Nuclear Power I—Grand Ballroom

Progress Report on the Dresden Nuclear Power Plant. *V. D. Nixson,* General Electric Co.; *J. J. Poer,* Commonwealth Edison Co.

Economic Nuclear Power—When? *W. L. Budge,* Westinghouse Electric Corp.

Superheated Steam from Nuclear Energy. *C. R. Braun, C. B. Graham,* Allis-Chalmers Manufacturing Co.

Central Station Plants and Auxiliaries—Louis XVI Room

Industrial Plants II—Assembly Room

A Generalized Computer Program for Evaluating Industrial Turbine Performance. *A. J. Klomparens, R. W. Hermanson,* Dow Chemical Co.

Novel Features of a New Central Power Plant to Replace Four Separate Plants. *H. H. Reisman,* Deere & Co.

Pond Surface Cooling for Chemical Plant Cooling Water. *Bruce Bardin, Alex Regan,* Union Carbide Chemicals Co.

System Planning and Operation—Crystal Room

Chairman: Nathan Cohn, Leeds and Northrup Co.

Co-Chairman: M. Riaz, University of Minnesota

New Tools Improve System Generalization Planning. *C. D. Galloway, L. K. Kirchmayer,* General Electric Co.

Operational Gaming and the Use of Mathematical Models for Developing System Economics and Planning. *C. J. Baldwin,* Westinghouse Electric Corp.; *C. H. Hoffman,* Public Service Electric and Gas Co.

Closing the Computer Loop on System Regulation. *W. J. Brogden,* Carolina Power and Light Co.

Progress in Automation of Electric Power System Planning and Operation. *C. Concordia, F. J. Maginniss,* General Electric Co.

10:30 a.m. Industrial Plants II—Assembly Room

12:15 p.m. Joint APC-WSE Luncheon—Bernard Shaw Room

Sponsored by WSE

Chairman: J. T. Rettaliata, president, WSE, and president, Illinois Institute of Technology

Speaker: A. S. King, president, Northern States Power Co.

Subject: The Challenge of the Power Industry

2:00 p.m. Afternoon Sessions

Nuclear Power II—Grand Ballroom

Gas-Graphite Suspension-Cooled Reactor. *G. K. Rhode, D. C. Schluderberg, E. E. Walsh, D. M. Roberts,* Babcock and Wilcox Co.

The Liquid Fluidized Bed Reactor. *M. R. Scheve,* The Martin Co.

Process Heat Reactors for Industry. *Frank Pitman,* Atomic Energy Commission

Condensers—Louis XVI Room

Computers and Network Analyzers—Crystal Room

Chairman. J. J. Carey, University of Michigan

Co-Chairman: E. B. Eggers, Illinois Institute of Technology

Application Experience Using Digital Computers for Fault Studies. *H. E. Brown, G. L. Landgren, W. W. Thorn,* Commonwealth Edison Co.

Models, Equivalent Circuits, Switching, and Energization Techniques of the Transient Network Analyzer. *I. B. Johnson,* General Electric Co.

Convergence of Digital Load-Flow Studies. *E. Van Ness,* Northwestern University

Automatic Read Out for A-C Network Analyzers. *O. J. Wallace, R. Galbreath,* Westinghouse Electric Corp.

Digital Print-Out Systems for A-C Network Analyzers. *C. M. Emslie,* Iowa State College

Network Analyzer Measurement of the Mesh Equivalent of a Complex Circuit. *J. C. Hogan,* University of Missouri; *V. E. Verrall,* Central Illinois Public Service Co.

Certificates Presented

John Tyner

IN RECOGNITION of service to the AIEE, Chicago Section Chairman F. A. Cox (*left*) presented Certificates of Appreciation to the following Section members: J. C. Woods (*center*), former director of the Institute (1955-59), and Dr. W. A. Lewis (*right*), former chairman of the National Standards Committee (1957-59).

Chase Ltd., Photo

PRESENTED for the first time, the Golden Omega Award *(center)* was given to Vice-Admiral H. G. Rickover *(left)* by Harold Boeschenstein *(right)*, president of Owens-Corning Fiberglas Corporation, at the Second National Conference on the Application of Electrical Insulation. The award ceremony took place at the "Unity of Action" banquet, one feature of the conference program.

Electrical Insulation Conference Attended by Industrial and Military Men

MANY of the men vitally connected with materials which have made possible today's missiles, rockets, jet airplanes, and atomic submarines as well as industrial machines, met in Washington, D.C., December 8-10, 1959, at the Second National Conference on the Application of Electrical Insulation.

Approximately 1,650 persons attended the meeting which was held at the Shoreham Hotel. Governmental, technical, and commercial exhibits showed the progress of electrical insulation in military and civilian fields.

The conference was co-sponsored by the AIEE and the National Electrical Manufacturers Association (NEMA). H. H. Chapman, Jr., of Owens-Corning Fiberglas Corporation, New York, N.Y., was general chairman.

Admiral Rickover Honored

A highlight of the Second National Conference was the "Unity of Action" banquet at which the electrical insulation industry honored Vice-Admiral H. G. Rickover with the "Golden Omega Award," in recognition "of his outstanding achievements in the use of nuclear power and the improvement of electric equipment design." It is a strikingly designed award, sponsored by *Insulation* magazine, to be given annually to a man of science, without limitation to any particular scientific field. Harold Boeschenstein, president of Owens-Corning Fiberglas Corporation, and toastmaster at the official "Unity of Action" banquet which was held at the Sheraton-Park Hotel, made the presentation. This is the first time the annual award was presented.

Secretary of the Army W. M. Brucker was the principal dinner speaker. The banquet was organized on the theme that "the nation's educational institutions and the manufacturers of materials, electric and electronic equipment, must be unified in their efforts to enable industry to meet the rapidly changing technology pertaining to the Space Age."

Permeating the technical work was the reminder that the armed services and industry are clamoring for more power per pound. The trend is towards miniaturization, specifically smaller motors for missiles, rockets, submarines, atomic installations, and vehicles. The demand is for more compact motors, transformers, and components which are thinner, lighter, more heat resistant, and impervious to contaminants.

How flat "harnesses" consisting of conductors sandwiched between two plastic films are finding new applications in the field of air-borne electronics was described in a paper by R. W. Korb, J. C. Case, and V. C. Lazzaro of Hughes Aircraft Company, Culver City, Calif. "These applications, mainly designs involving the transmission of electric energy to oscillating devices such as antennas and resolvers" are directed to "operate anywhere from—65 to 400 F," and at sea level to 80,000 feet altitude in unpressurized compartments, with a life of 2,000 hours.

"High temperature (Class H) transformers are available today in a wider variety of sizes and types than were thought possible a few years ago," H. W. Dornbush, of the Pennsylvania Transformer Division, McGraw-Edison Company, said in a paper. "The proven reliability and resistance to moisture even permits the use of ventilated transformers in coal mines where they are continuously in a high humidity atmosphere. Although of course not recommended, a Class H unit has been known to operate while being sprayed with water!"

A paper describing wire insulated with resin which can endure temperatures of 842 F and above for short periods was delivered by J. J. Casey, Bureau of Ships, Department of the Navy, and J. P. Shoffner, polychemicals department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Such wires, with a survival capability of 4 to 6 hours, they said, are "of significance in 'one shot' applications, such as missile launching, transient overloads, etc."

The extreme tests made on insulation for a new 220 C Class of dry-type transformers for the U. S. Navy in 1948 were described in a paper by F. J. Brutt, of Westinghouse Electric Corporation, Sharon, Pa. "Eight standard transformers were operated at sufficient overload to maintain an average winding temperature of approximately 250 C for 1,000 hours. The units were periodically insulation tested while hot and again tested after subjection to 100% humidity. This was followed by the next cycle for a total of five equal cycles. . . All units withstood normal dielectric tests following the life test. . . It is to be pointed out that the subsequent 10 years of field experience has well proven this insulation system." The Navy, he said, is still using this line of transformers. Principal materials used in the insulation were silicone varnishes, mica, asbestos, and glass materials.

AIEE Committee

A "European Insulation Technology Luncheon" was organized by the AIEE Electrical Insulation Committee, under the chairmanship of K. N. Mathes, of the engineering laboratory of General Electric Company at Schenectady, N. Y. Principal speaker invited was Dr. W. J. K. Oburger, deputy director, Austrian Productivity Center. A session of the Distribution Equipment Section was concerned with foreign practices in insulation application. One of the speakers listed was J. H. Mason, of the Electrical Research Association, Leatherhead, Surrey, England.

The trend in industry is for smaller motors and higher voltages, but today's insulation engineer has greater latitude in his choice of insulation materials, P. W. Jones, of the Rostone Corporation, said in his paper. "Whereas 200 volts was quite common 20 years ago for industrial applications, 440 volts and higher gained favor through the years, and in some countries, 550 volts is almost universal." He described a new type of inorganic insulation for arc resistance and interruption. "These molded compositions commonly called 'cold-mold' have binders of calcium alumino-silicate or cement, with asbestos fibers. Being inorganic, they cannot carbonize. The melting point exceeds 2,000 F."

The need to produce "more power per

pound" is especially applicable to shipboard installations. C. R. Atkinson, of General Electric Company, Schenectady, said in his paper.

Problems derived from the fact that "higher speed aircraft, missiles, and nuclear reactors require electric equipment capable of operating at ambient temperatures of 800 F and higher" were discussed by J. C. Davis and J. T. Wilson of the Louis Allis Company.

A new high temperature (Class H) impregnating silicone resin varnish which cures in ovens such as most electric shops already have, as temperatures higher than 300 F are not required, was described by J. B. Toogood, of Silicones Division, Union Carbide Corporation. This same subject was dealt with by A. E. Horning, of silicones product department, General Electric Company. He explained that innovations in silicone resin technology allow their entry into the lower temperature classifications thereby affording the many benefits of silicones which heretofore were unrealistic on a cost basis.

An analogy between the vanishing Indians and the ever-increasing demand for smaller insulation systems was evoked in a paper by J. S. David of General Electric. "Can there be any disagreement that a truly ideal electrical insulation should emulate the vanishing American? In other words, we should like our insulation to occupy no volume, to be weightless, but still to perform its function as a dielectric barrier impervious to contaminants and with perfect heat transfer characteristics."

Space Technology Conference

3-Day Program Provides for 5 Sessions

THE CONFERENCE on Electrical Engineering in Space Technology will be held April 11-13, 1960, at the Hotel Baker in Dallas, Texas. The meeting is being sponsored by the AIEE in joint participation with the Institute of Radio Engineers and the American Rocket Society.

The tentative program has been announced as follows:

Monday, April 11

9:00 a.m. Session I

Presiding: J. H. Foote, president, AIEE

Theme: "An Over-All Look at the National Space Picture"

This session will feature talks by prominent civilian and military officials concerned with the national space program.

2:00 p.m. Session II

Theme: "The Space Age Viewpoint in the Fields of Communication, Feedback Control, Electric Energy, and Instrumentation"

General Applications and Requirements in Space Communications. Representative from Jet Propulsion Laboratory

Guidance and Control for Space Vehicles. *A. C. Hall*, Martin-Denver.

The Role of Electric Energy in Space Application. *A. W. Thompson*, ABMA

Instrumentation for Space Science. *Herbert Friedman*, Atmosphere & Astrophysics, NRL

Seminar

Conducted by members of the American Rocket Society (ARS)

Discussion area by ARS Committee: M. Lowy, Communications; L. S. Brown, Guidance and Navigation; A. Zarem, Power Systems; and H. Friedman, Instrumentation.

7:15 p.m. Dinner

Speaker: Dr. J. R. Pierce, director of research, Bell Telephone Laboratories

Address: "Adventure in Space Science (Fiction)"

Tuesday, April 12

9:00 a.m. Session III

Theme: "Specific Missions, Requirements, and Problems of Some U. S. Missiles, Space Vehicles, and Payloads"

Project Mercury. *John Disher*, National Aeronautic and Space Administration

Space Vehicle Payloads. Representative from Jet Propulsion Laboratory

Electric Subsystem Requirements in the ARPA Satellite. *G. W. Brady*, assistant director, Advanced Research Projects

Agency and Institute of Defense Analysis Nike-Zeus System. Representative from U. S. Army, ARGMA

The Polaris System. Representative from U. S. Navy, Special Projects Office

Minuteman. Representative from U. S. Air Force, Ballistic Missiles Division

Luncheon

Speaker: Dr. L. V. Berkner, president, Associated Universities Inc.

Address: "Education and Space Technology"

2:00 p.m. Session IV

Theme: "Developments in the Fields of Communication, Control, Electric Energy Conversion, and Instrumentation"

Problems of Communication. *J. R. Pierce*, Bell Telephone Laboratories

Developments in Flight Vehicle Control. *J. R. Moore*, NAA

Developments in Electric Energy Conversion and Utilization. *W. Menetry*, Electro-Optical Systems

Developments in Instrumentation. *E. P. Felch*, Bell Telephone Laboratories

Seminar: Basic Electrical Engineering Materials

Insulation Materials. *R. N. Evans*

Magnetic Materials. *R. M. Bozorth*, Bell Telephone Laboratories

Solid-State Materials. *W. C. Dunlap*, Raytheon

Wednesday, April 13

9:00 a.m. Session V(a) Communication

The Propagation Problem; Long Range Transmission and Reception. *R. G. Stephenson*, Space Technology Laboratories

World-Wide Communication Through Active Satellites. *Louis Pollack*, International Telephone and Telegraph Laboratories

New Developments in Solid-State Electronics. *D. A. Jenney*, Radio Corporation of America Laboratories

Design of a Communication Satellite System. *Donald Culler*, International Telephone and Telegraph Laboratories

Optical Communication Methods for Space. *Earle Brown*, Farrand Optical Co.

9:00 a.m. Session V(b) Feedback Control

Problems Associated with Interplanetary Guidance. *P. E. Kendall*, International Telephone and Telegraph Laboratories

Space Vehicle Control Capabilities. *F. E. Digesu*, Army Ballistic Missiles Agency

Self-contained Ion-Propelled Orbital Control Systems. *E. Walthall*, Radio Corporation of America Astro-Electronics.

Automatic Flight Control with Emphasis on Reliability. *O. Ostlund*, Minneapolis-Honeywell.

Development of Reduced Weight Inertial Guidance Equipment. *A. E. Fyffe*, General Motors Corp.

9:00 a.m. Session V(c) Electric Energy Conversion

Current Status of Thermoelectric and Photovoltaic Methods. Representative from Westinghouse

Current Developments in Compact Nuclear Systems. *Frank Meyers*, Martin—Baltimore

Electrochemical Methods. Representative from U. S. Army Signal Research and Development Laboratories

Unconventional Electromagnetic and Electrodynamic Methods. *J. T. Duane*, General Electric Co.

The Ultimate Today in Minimum Weight Electric Generators, Representative from Bendix—Redbank

Vehicular Support Power. *J. I. Elliott*, Martin—Baltimore

9:00 a.m. Session V(d) Instrumentation

Instrumentation for Physiological Experimentation—1. Biological Functions. *H. G. Clamann*, U. S. Air Force School of Aviation Medicine

Instrumentation for Physiological Experimentation—2. Transducers. *W. Welkowitz*, Gulton Industries

Instrumentation for Meterology. Unannounced

Comparative Telemetry Systems. *M. Burns*, Radiation Inc.

Data Reduction and Computation in Space Instrumentation. *S. N. Alexander*, National Bureau of Standards

Utilization of Re-entry Vehicles for Space Laboratory Experiments on Thor and Atlas Ballistic Missile Programs. *L. E. Foster*, General Electric Co.

Wear Your

AIEE Badge

AN ADDRESS by Dr. H. F. York *(left)*, director of Defense Research and Development, Department of Defense, was given at the EJC dinner. Dr. York was introduced by Dr. A. B. Kinzel *(center)*, 1960 EJC president. E. R. Needles *(right)* was the EJC president in 1959.

Annual EJC Meeting Concerned with Future Plans and Past Activities

Many of the past year's activities of the Engineers Joint Council (EJC) as well as plans for the future were summarized at an all-day annual meeting held January 22, 1960, at the Statler Hilton Hotel, New York, N. Y.

Among items discussed at the Board of Directors meeting, held during the morning, was the appointment of a replacement for the post of EJC secretary, left vacant by the resignation of E. P. Lange. A motion was passed that L. K. Wheelock assume the position on an acting basis until further recommendations are made by the Executive Committee.

Following the presentation of the treasurer's report, Cecil Boling, chairman of the Ad Hoc Committee on Committees, submitted recommendations for modifications of the EJC committee structure.

E. J. Kates, chairman of the Membership Committee, reported that the qualifications of the American Railway Engineering Association have been reviewed and found favorable. A formal application may be anticipated shortly.

International Relations

G. A. Hathaway, chairman, International Relations Committee, discussed plans for the presentation of five papers at the Pan American Congress on Engineering Education, sponsored by UPADI, the Pan American Federation of Engineering Societies. The meeting will take place in September 1960 at Buenos Aires, Argentina. He also described progress made in the Pacific-Far East Federation. The majority of the countries involved are in favor of the formation of the federation.

Final plans and the program for the 1960 Nuclear Congress, to be held in New York April 4-7 (see p. 230), were outlined briefly by D. P. Reynolds.

G. C. Pearl reported on progress in the field of public relations, through use of advertisements and displays being prepared for insertion in society and trade publications.

A progress report on the scheduled EJC mission to the Soviet Union this Spring for the study and evaluation of the utilization of engineers was reported by W. E. Lobo. Among the subjects of interest were the use of technicians in supplementing the work of engineers and the role of women in engineering.

J. S. Koss discussed plans for bringing five engineering authorities from Europe for a comprehensive lecture tour of United States engineering schools and major meetings of the various engineering societies. A grant has been received from the National Science Foundation (NSF) to finance this program. The secretaries of five of the engineering societies have been requested to make recommendations for the choice of suitable lecturers.

C. S. Proctor, EJC representative to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), summarized a written report to the Board on activities of the past year. He stressed the value of the engineering profession's having a voice in the work of UNESCO.

In a luncheon address, E. R. Needles, outgoing EJC president, reviewed the progress and achievements of the EJC, both in unifying the engineering profession and in strengthening its role in national and international affairs. He pointed out its strong and growing relationship with NSF and UNESCO. Among items on the current EJC agenda are plans for participation in the 1964 New York World's Fair.

During the afternoon, an open meeting was held to permit a clearer understanding of some of the aims and projects of the EJC. The meeting was brought to order by President-Elect A. B. Kinzel.

Engineers' Register

H. H. Osborne discussed the matter of an engineers' register, now under review by the NSF. It is estimated that such a register would comprise some 800,000 United States engineers. The purpose of such a register would be to facilitate the location of men with particular skills, and to provide the Government with valuable statistical information. The deadline for EJC recommendations is June 30, 1960.

Cecil Boling, vice-president-elect and Planning Committee chairman, recommended that the Planning Committee should look into the possibility of greater local activity, the need for expanded public relations and communication, the need for additional financial support, better liaison with Government agencies, and closer ties between the governing bodies of EJC and those of the constituent societies.

F. D. Kay, chairman of the Membership Committee, discussed the expansion of the definition of "engineers" so that certain specific societies that "promote the art and science of engineering" may be included.

The proposed EJC-ECPD (Engineers' Council for Professional Development) merger was described by W. L. McCabe of ECPD. Under the proposed amalgamation, the EJC charter would be used as the basis for the new organization, to be called American Engineers Association, Inc., or some other name acceptable to both groups. Under this setup, EJC and ECPD would act as parallel operating divisions. The Engineering Manpower Commission might be included as a third operating division. The membership would remain the same as at present. He emphasized that the plan is *not* a device for absorbing ECPD into EJC.

A. B. Kinzel discussed plans for a newspaper, to be used as a means of communication between EJC and members of the constituent societies. A sum of $15,000 has been set aside for this purpose. It is anticipated that the first issue will be forthcoming shortly.

EJC Annual Dinner

The feature of the EJC annual dinner was an address, "Defense Research and Engineering" by Dr. H. F. York, director of Defense Research and Development, Department of Defense. The missile and space program in the Department of Defense was outlined by Dr. York from the viewpoint of military requirements, tim-

ing in relation to Soviet progress, organization, and general objectives. He explained that the United States, with nearby bases, first concentrated on missiles while the Soviets concentrated on an outer space program; hence, this country was about 2 years behind with the American rocket which was one-half the size of the Soviet rocket. He said that our biggest rocket has yet to be used and tests would begin this year.

Dr. York explained that it was a good decision to develop missiles big enough to do the job and no bigger, as the cost was almost proportional to the size of the vehicle. On the other hand, space-vehicle costs work the other way around and it is always advantageous to make them larger. The view was expressed that this country was ahead in the thermonuclear program.

With respect to organization, Dr. York explained the division of work between the Department of Defense, which is strictly related to systems used for defense, and the National Aeronautics and Space Administration, which is responsible for all programs in space flight. It was stated that there was no certainty that everything in 1960 to 1970 would be concentrated on missiles; hence, the *B70* is being developed and aircraft nuclear propulsion is considered a breakthrough. The flexibility of keeping options open is desirable; and if the programs for the Nike and Zeus missiles should be stopped, we would cease learning about the re-entry, guidance, and other problems. The objective is to keep as many options open as possible as the cost is only 5% of what a full program would cost.

Considerable enthusiasm was evidenced by a number of questions after the talk which were answered by Dr. York. In regard to the Titan missile, he explained that the Titan and the Atlas were much alike with about the same range, payload, etc. He stated that the accuracy of the Soviet missile fired in the Pacific within 2 kilometers of the target after a flight of 6,000 or 7,000 miles was no surprise. In regard to the standards for bridges and permissible loading, it was explained that the sizes of missiles are becoming smaller. In regard to the outer space photographs given out by the Soviets, Dr. York stated that the photographs were authentic and a good contribution to science. With reference to a question as to whether more good engineers or good scientists were required, Dr. York said that more good people were required and it did not make any difference whether they were engineers or scientists.

The speaker was introduced by Dr. A. B. Kinzel, EJC president, who explained that Dr. York was a protégé of Dr. Ernst Lawrence of the University of California and when the Livermore Laboratory was established Dr. York was appointed director.

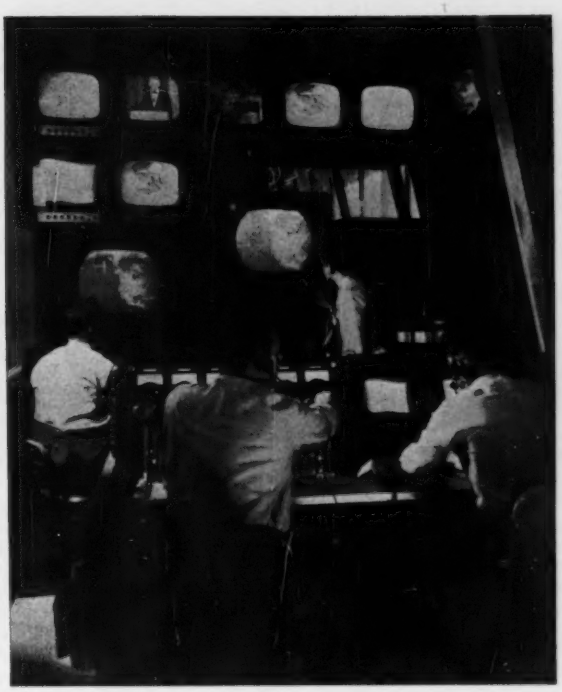
EJC Undertakes "Visiting Scientist" Program

Engineers Joint Council (EJC) will undertake a "visiting foreign scientist" program in engineering during the next few months. This program is intended to broaden the scientific perspective of faculties and graduate students in engineering through interchange of scientific knowledge and research concepts with prominent foreign scientists. The program is made possible by a grant of $25,000 from the National Science Foundation.

In announcing the grant and the program, E. R. Needles, president of EJC, said: "Although this program is planned primarily to aid departments of engineering with Ph.D. programs and active research activities, attention will also be given, when possible, to the needs and desires of institutions whose developing programs of teaching and research could be given strong impetus by such visits. The invited foreign scientists will also be given an opportunity to visit appropriate engineering society meetings and nonuniversity research organizations."

The visiting scientists will be chosen by the appropriate engineering society in five specialty areas to assure that outstanding, creative, research-minded scientists are invited to participate.

J. S. Koss, staff assistant of EJC, will direct the program.



A TOUR through the underground worldwide control center of the National Defense Strategic Air Command Headquarters has been planned as a feature of the Rural Electrification Conference which will be held May 10-12, 1960, in Omaha, Nebr. A view is shown (*right*) in the control room for the Strategic Air Command Headquarters' closed-circuit television briefing system.

U. S. Air Force Photo

Rural Electrification Conference Scheduled in May

AIEE members have been urged to reserve May 10-12, 1960, to attend the AIEE Rural Electrification Conference in Omaha, Nebr.

The demands of the farmer, rancher, and feeder for labor-saving devices is a challenge to all phases of the electrical industry.

Those who attend the conference will have an opportunity not only to learn but to share their views with others.

A tour through the underground worldwide control center of the Strategic Air Command Headquarters has been scheduled on a first-come first-served basis.

Participants have been advised to return their advance registration cards to the conference committee as soon as possible after the cards are received.

Action Advised To Assure Availability of U. S. Engineers

The United States must decide and take action now to insure the availability of enough engineers and the right kind of engineers to meet the expanding demand for technical services of the 1960's, according to a report released by the Engineering Manpower Commission of Engineers Joint Council (EJC).

The report follows the announcement by the U. S. Office of Education that freshman engineering enrollment has declined for the second consecutive year, more than 3% in 1959 after an 11% drop in 1958. This, says the Manpower Commission's report, is an unexpected trend when the demand for engineers is increasing and is expected to accelerate, especially when the nation is committed to a world contest which depends largely on a sufficient supply of engineering brainpower.

The Engineering Manpower Commission points to these facts:

1. Because of enrollment drop, for the next 5 years it is expected that 37,500 engineers will graduate each year, against pre-1958 predictions of close to 43,000.

2. Only 2% of the coming college-age group will be available for engineering.

3. Between January 1953 and January 1959, the number of engineers in industry rose from 409,000 to 630,000, an increase of 138,000, or more than all the engineering bachelor degrees awarded.

4. Business cycle changes have only a temporary effect on the demand for engineers.

5. By 1966, more than two engineers will be hired for every one this year.

6. The Gross National Product, closely related to productivity, depends on the supply of engineers.

The Manpower Commission concludes that the two basic objectives which must be met are: the best use of available engineering manpower and sufficient engineering graduates.

To meet the objectives, the Commission advocates:

1. Insuring that engineers and engineering technicians are used to their best capacity in industry, Government, and education.

2. Increased recognition of engineers at Government level.

3. Making it possible for engineers to discharge their service to the nation in either civilian or military positions in the best public interest.

4. Improving the quality of all education.

5. Improving public relations of engineers and engineering through parents, students, guidance counselors, industry, and Government.

J. W. Feiss, chairman of the Engineering Manpower Commission, stated: "The Commission will strive toward the achievement of these objectives and will issue statements to further amplify these long-term views. We invite the support and co-operation of other organizations and individuals concerned with the vital problem of fully developing our engineering manpower resources."

The Commission's report, entitled "Engineering Manpower and the National Interest" is available free in quantity at the Engineering Manpower Commission, 29 W. 39th St., New York 18, N. Y.

Past Committee Service Noted by Philadelphia Section

Certificates of appreciation for previous committee service to the Institute have been awarded by the Philadelphia Section, AIEE. The certificates were presented January 11, 1960, at the regular meeting of the Section, held in the Engineers Club, Philadelphia, Pa.

Awards were made to the following: F. T. Chesnut, chairman of the Electric Heating Committee; L. R. Gaty, chairman of the Publications Department Committee; G. L. Hollander, chairman of the Digital Computers Subcommittee; R. M. Hutchinson, chairman of the Liaison Subcommittee of the Feedback Controls Systems Committee; J. W. Jones, chairman of the Synchronous Machinery Subcommittee; Will McAdams, chairman of the Instrument Subcommittee; Morris Rubinoff, chairman of the Computing Devices Committee; H. H. Sheppard, chairman of the Sections Committee; G. B. Schleicher, former Section chairman; and A. M. Fuchs, chairman of the Programs Subcommittee of the Feedback Controls Systems Committee.

The awards were made by R. S. Hewett, current chairman of the Philadelphia Section.

Materials Handling Conference Program Given

The AIEE technical conference pertaining to the electrification of materials handling equipment will be held in the Sheraton Hotel, Philadelphia, Pa., on April 12-13, 1960. The conference will be sponsored by the Materials Handling Subcommittee of the General Industry Applications Committee.

The technical program will consist of three half-day sessions during which nine topics will be discussed by 12 speakers. Included will be two presentations each on the subjects of static switching systems and components, and industrial fork-lift trucks, and single presentations on automated material control, conveyor applications, missile handling, and/or unloaders. A panel presentation of three speakers will discuss: "Motor Selection for A-C Cranes for Continuous Duty Applications."

On the afternoon of April 13, inspection trips will be made to the plants of the Yale and Towne Manufacturing Company

RECIPIENTS of appreciation certificates from the Philadelphia Section, AIEE, for past committee service in the Institute were the following: (*left to right*) F. T. Chesnut, L. R. Gaty, G. L. Hollander, R. M. Hutchinson, J. W. Jones, Will McAdams, Morris Rubinoff, H. H. Sheppard, and G. B. Schleicher. A. M. Fuchs, another former AIEE committee member in the Philadelphia Section, was absent when the photograph was taken. The certificates of appreciation were awarded at a recent Section meeting.

and the Electric Storage Battery Company.

The 1960 Materials Handling Conference is the fourth one to be held in recent years. Previous conferences were held in Cleveland (1955), Pittsburgh (1958), and Milwaukee (1959).

The technical program was arranged by the National Subcommittee which consists of 27 representatives of materials handling equipment manufacturers, equipment users, electric equipment manufacturers, consulting engineers, and the Department of the Navy. Officers of the Subcommittee are H. A. Zollinger, chairman, Westinghouse Electric Corporation; R. F. Rice, vice-chairman, Whiting Corporation; and William Kutcher, secretary, EC&M Division of Square D Company. The local arrangements for the conference are being handled by an eight-man committee of AIEE members in the Philadelphia area. B. F. Bennett is chairman of the Local Arrangements Committee.

A program announcement and registration cards will be distributed to those on a number of specially prepared mailing lists early in March.

The tentative program for the conference follows:

Tuesday, April 12

8:30 a.m. Registration

9:30 a.m. Morning Session

Static Systems for Power and Control Applications. *B. Mokrytzki; B. Beattie,* Westinghouse Electric Corp.

12:15 p.m. Luncheon

2:00 p.m. Afternoon Session

Chairman: T. F. Burris, Chesapeake and Ohio Railway Co.

Unusual Conveyor Applications. *George Mather,* Colmar Plant, Link Belt Co.

Automated Materials Control. *H. Gleixner, D. W. Shenton,* General Electric Co.

The Big Pier Gets Bigger, *R. J. Clarke,* Pennsylvania Railroad Co.

Wednesday, April 13

8:45 a.m. Morning Session

Chairman: O. S. Carliss, Yale and Towne Manufacturing Co.

Operation and Maintenance of a Large Electric Lift Truck Fleet. *Thomas Massey, Jr.,* Bethlehem Steel Co.

Panel: Motor Selection for A-C Cranes for Continuous Duty Applications.

Need for Motor Selection. *Harland Poland,* Harnischfeger Corp.

Hoist Motor Selection. *A. Nitsch,* General Electric Co.

Bridge and Trolley Motor Selection. *H. A. Zollinger,* Westinghouse Electric Corp.

Call Made for Papers for AIEE–IRE Conference

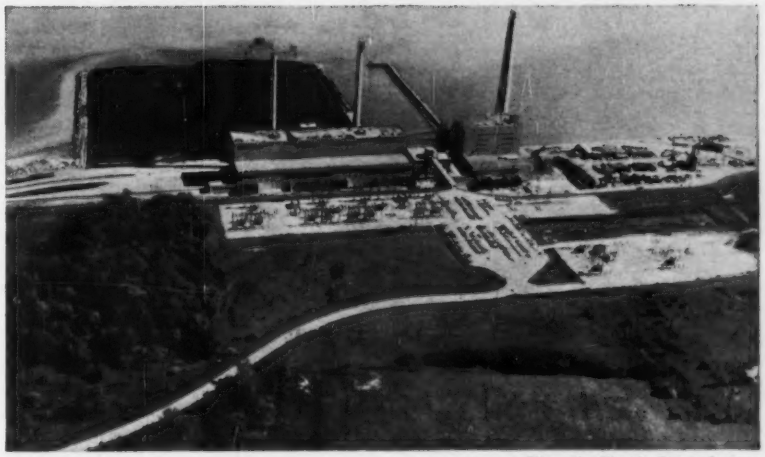
The fifth annual Conference on Nonlinear Magnetics and Magnetic Amplifiers will be held on October 26-28, 1960. The conference is sponsored by the AIEE Committee on Magnetic Amplifiers and the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics with co-operation from the Professional Group on Electronic Computers.

The technical program will consist of sessions devoted to:

1. *Computer Magnetics.* This category includes: magnetic memory components, devices and systems; and magnetic logic elements and circuits.
2. *Combined Semiconductor and Nonlinear Magnetic Devices.*
3. *Theory Design and Application of Magnetic Amplifiers.* This includes such topics as low-level amplifiers, high frequency operation of magnetic amplifiers, ferroresonant circuitry, and magnetic devices for extreme environments.

Authors are invited to submit abstracts of papers to: the Technical Program chairman, David Katz, Bell Telephone Laboratories, Whippany, N. J., by March 15, 1960. Abstracts should be 200 to 400 words in length. Final manuscripts must be submitted by July 15, 1960. Papers may be submitted for the conference only or for AIEE *Transactions* status as well. All papers will be published in the Conference Proceedings which will be available at the meeting.

An additional feature of the conference will be exhibits by leading manufacturers of cores, semiconductor devices, magnetic amplifiers, and associated apparatus.



Wisconsin Electric Power Company

A TOUR of the Oak Creek Power plant of the Wisconsin Electric Power Company will provide visitors with an opportunity of viewing both the mechanical and electrical functions of the newest unit installed in the power plant. This unit has a capacity of 275,000 kw and is connected to the system through a 230,000-volt substation. Some of the parts of the plant that will be seen are the electrical control center, outdoor switchyard, electrical load centers, turbine boiler control center, boiler room, and turbine room. The tour will be made during the Great Lakes District Meeting in April.

Great Lakes Meeting To Highlight Control Papers

The Great Lakes District Meeting will be held in Milwaukee, Wis., on April 27-29, 1960. Headquarters will be located at the Pfister Hotel. The theme for the meeting is "Controls—Pearl Street to Cape Canaveral."

Co-ordinated with 70 technical papers will be 8 plant tours to the following companies: AC Spark Plug Company, Allen Bradley Company, Allis-Chalmers Manufacturing Company, Cutler-Hammer Company, Line Material Company, Louis Allis Company, Square "D" Company, and Wisconsin Electric Power Company.

The technical papers will convey, in words and actual observations, the control engineering influence in the field of industry, transmission and distribution, missile guidance, communication, domestic appliances, machine tools, and rotating machinery. Also included in the program will be papers on education and student papers.

A few of the titles of the papers to be given are as follows:

Effect of Electrodynamic Forces on Contacts. *A. C. Snowden,* Cutler-Hammer, Inc.

Electrostatically Influenced Force Transmitting Fluids. *J. A. Mason,* Warren Brake Co.

Application of Digital Computers to Process Control Problems. *R. S. Gillett,* General Electric Co.

Space Vehicle Attitude Control System. *J. W. Dunham, R. P. Peterson, D. A. Liebemann,* Booz-Allen Applied Research Co.

Attitude Control for an Unmanned Interplanetary Vehicle. *E. J. Frey,* Massachusetts Institute of Technology.

New Engineering Curricula. *H. J. Peterson,* University of Wisconsin; *J. Horgan,* Marquette University; *R. J. Ungvodt,* Milwaukee School of Engineering.

Survey of Russian Technology—Feedback Systems. *T. J. Higgins,* University of Wisconsin.

Entertainment for the ladies will include tours of the Milwaukee Memorial Art Center, Junior House, a dress factory, and a boat tour of Milwaukee Harbor, if the weather permits.

ASEE Issues Revised Statement on Recruiting Practices and Procedures

THE American Society for Engineering Education (ASEE) has published a statement of "Recruiting Practices and Procedures—1959."

A copy of this report follows:

Foreword

Certain recruitment practices have developed from time to time, in the stress of competition for engineering graduates, which have not been consistent with professional standards. In 1948, a committee appointed by ASEE first studied this problem and published "Ethics of Interviewing Procedures" in 1949.

In 1956, accelerated competition for engineering graduates again occasioned some shortsighted recruitment practices. The ASEE Committee on Ethics decided to revise the 1949 publication. The Midwest College Placement Association (MCPA) also appointed a committee to study the problem, and as a majority of its membership was also affiliated with the ASEE, arrangments were made to review the MCPA committee recommendations.

The Committee on Ethics then published a revision titled "Recruiting Practices and Procedures" in April 1957. Several months later, the College Placement Council, Inc., and the Chamber of Commerce of the United States jointly issued a statement on "Principles and Practices of College Recruiting."

In September 1958, a "task force" representing the ASEE Committee on Ethics and the College Placement Council, Inc., met to resolve the differences between the two "codes." The 1959 revision of "Recruiting Practices and Procedures" which follows represents the combined efforts of the "task force" with the exception of item 7 under "Employer Responsibilities." This item contains greater detail about conditions of employment that are most important to engineering students. The ASEE Committee on Ethics believes this detail is essential to the implementation of the "General Principles" expressed in the "code" and consistent with the best interests of the engineering profession.

This statement of "Recruiting Practices and Procedures" has been endorsed by the Ethics Committee of the Engineer's Council for Professional Development (ECPD) and constitutes a supplement to the ECPD Canons of Ethics. Its purpose is to aid in the development and maintenance of high ethical standards in the procedures of college recruiting and in the relations between the employing organizations, college authorities, and college students who are engaged therein.

General Principles

It is in the best interests of students, colleges, and employers alike that the selection of careers be made in an objective atmosphere with complete understanding of all the facts.

Therefore, the recruiting of college students for employment by business, industry, government, and education should be carried out by the employers, students, and college authorities to serve best the following objectives:

1. To promote a wise and responsible choice of a career by the student for his own greatest satisfaction, minimum wasteful turnover, and most fruitful long-term investment of his talents for himself, for his employer, and for society.
2. To strengthen in him a high standard of integrity and a concept of similar standards in the employing organizations of the country.
3. To develop in the student an attitude of personal responsibility for his own career and advancement in it, based on performance.
4. To minimize interference with the educational process of the college and to encourage completion of the individual's plans for further education.

Practices and Procedures

Responsibilities of the Employer

1. The employer should contact the Placement Office well in advance regarding desired interview dates, broad categories of employment expected to be available, college degrees, and other pertinent requirements. He should advise promptly any change in his original request or subsequent arrangements with the Placement Office.
2. The employer should provide suitable literature to give students a true and factual picture of the employing organization. This material should be supplied in sufficient quantities and well in advance of the interviewing date.
3. When both the parent organization and subsidiary or affiliated organization conduct interviews in the same college, the respective interviewers should explain clearly their missions and the connections, both to the Placement Office and to the students.
4. Not more than two and preferably only one interviewer representing an employer should appear for each interview schedule. Arrangements for more than two interviewers should be made in advance, and only for reasons considered adequate by the Placement Office.
5. The Placement or other appropriate officer of the college should be advised in advance of any plans for campus visits by the representatives of an employer, including alumni of the college, to acquaint faculty members or students with company employment activities or opportunities. Such representatives should exercise scrupulous care to avoid undue demands on the time of faculty members or students.
6. An employer who desires to contact an individual student at the time of his interview should communicate with the individual well in advance, with a notice to the Placement Office.
7. The interviewer should clearly explain to the Placement Office and students any special requirements such as the passing of tests, physical examinations, signing of patent agreements, or if his job is affected by any union contract.
8. The interviewer should be punctual. He should tell the Placement Office when he will arrive as well as his expected departure time. Every effort should be made to avoid last minute cancellations.
9. The interviewer should very carefully follow the interview time schedule agreed upon with the Placement Office.
10. As soon as possible following an interview, the employer should communicate with the student and the Placement Office concerning the outcome of the interview.
11. The employer should give the student reasonable time to consider his offer, and in no case should the student be pressured into making a decision concerning employment.
12. If the employer invites a student to visit his premises for further discussion of employment, the visit should be arranged to interfere as little as possible with class schedules. He should explain what expenses will be paid, how and when. Invitations for this purpose should be made only on an individual basis and the employer should avoid elaborate entertaining or overselling.
13. The employer should not offer a student special payments, gifts, bonuses, or other inducements, nor should he compensate or favor a third party to prevail upon the student to accept an employment offer.
14. Employers should not raise offers already made except when such action can be clearly justified as sound industrial relations practice, such as when an increase in hiring rate is required by an over-all basis to reflect salary adjustments in the employing organization.
15. The employer should keep the Placement Office informed concerning his interest in particular students and his negotiations with them.
16. When a student has declined a job offer, the employer should accept that decision as final. If for any reason the employer wishes to re-establish contact with the student, he should do so only through the Placement Office.
17. The employer should engage each student who has accepted his offer except when failure to do so is the direct result of contingencies explained during the interview or unavoidable economic factors not foreseen when the offer was made.

Responsibilities of the College

1. As part of its general obligation for the development of the student, the college should accept responsibility for stimulation of his thinking about his career objectives and for assistance in overcoming handicaps which may hinder his progress toward objectives appropriate for him. Competent counseling services should be provided for this purpose, available to individual students.
2. The Placement Office should inform employers concerning the number of students available for interview in the several

curricula, and the dates of graduation. This information should be sent as soon as it is available.

3. The Placement Office should announce to students early in the school year which employers will interview students and when. The Placement Office should make revised announcements from time to time as may be necessary.

4. The Placement Office should make employment literature available to students and faculty.

5. When an employer is looking for graduates in several fields (e.g., engineering, psychology, physics) the Placement Office should issue announcements to all qualified students concerned, and so far as practicable, should schedule interviews for those who express interest.

6. The Placement Office should not restrict the number of interviews per student, except as necessary to discourage indiscriminate "shopping."

7. The college should provide adequate space and facilities for quiet and private interviews.

8. The Placement Office should provide interviewers with available records of those students in whom they are interested.

9. The Placement Office should arrange for interviewers to meet faculty members who know students personally and can provide information about their work and qualifications.

10. The Placement officer and faculty members should counsel students but should not unduly influence them in the selection of jobs.

11. The Placement Office should make certain that students are acquainted with this statement of "Principles and Practices of College Recruiting."

Responsibilities of the Student

1. In seeking company interviews, the student should recognize his responsibility to analyze his interests and abilities and consider carefully his career objective and appropriate ways of meeting it. He should read available literature and consult other sources of information about the employer and organize his thoughts in order that he may intelligently ask and answer questions.

2. The student should contact the Placement Office well in advance regarding desired interviews or cancellations.

3. The student should use care in filling out such forms as may be requested in preparation for interviews.

4. In his interviews, the student should recognize that he is representing his college, as well as himself, and should be punctual and thoroughly businesslike.

5. The student should promptly acknowledge an invitation to visit an employer's premises. He should accept an invitation only when he is sincerely interested in exploring employment with that employer.

6. When a student is invited to visit an employer's premises at the employer's expense, he should include on his expense report only those costs which pertain to the trip. If he visits several employers on the same trip, costs should be prorated among them.

7. As soon as the student determines that he will not accept an offer, he should immediately notify the employer.

Rothschild Photo

"SPRINGBOARD TO SPACE" was the topic of Lieut. Col. Nicolaus Gaynos' talk at a recent dinner meeting of the Los Angeles Section, AIEE. Colonel Gaynos is a staff officer of Vandenberg Air Force Base. The AIEE Communications Division and IRE were joint sponsors of the program. Shown are: (*left to right*) Dempster Burgess, IRE chairman; Fred Foulon, AIEE chairman; and Col. Gaynos.

8. The student should not continue to present himself for interviews after he has accepted an employment offer.

9. Acceptance of an employment offer by the student should be made in good faith and with the sincere intention of honoring his employment commitment.

10. The student should keep the Placement Office advised concerning his employment negotiations in accordance with the policy of his Placement Office.

Additional copies of this report may be obtained from: W. L. Collins, secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill. The price is 10¢ per copy, $1 for 25, $3 per 100.

Staff Officer Describes Vandenberg Air Force Base

More than 200 members of AIEE and the Institute of Radio Engineers (IRE) heard guest speaker Lieut. Col. Nicolaus Gaynos describe the Vandenberg Air Force Base program at a recent dinner meeting of the Los Angeles Section, AIEE. The meeting was sponsored jointly by the AIEE Communications Division and the IRE.

Colonel Gaynos is communication-electronics staff officer, 1st Missile Division, at Vandenberg—newest of the nation's three missile firing ranges.

Illustrating his talk with color slides, Colonel Gaynos explained the threefold mission of the 64,000-acre base. The first goal is to achieve and maintain the ability to fire intercontinental ballistic missiles (ICBM); the second, to train Intermediate Range Ballistic Missile and ICBM teams; and last, to support the nation's missile-satellite program. Command control nets, extensive nets for logical and simulated tactical controls, guidance, and electronics systems for the Atlas, Titan, and Thor weapons systems are a few of the communications facilities and operational electronics installed to support missile training and satellite firing capabilities.

Colonel Gaynos and his staff regard the concept of "communications–electronics" as one word since communications command nets and electronic guidance and control systems are closely interwoven.

Nuclear Engineering Added to Purdue University Curriculum

Organization of a department of nuclear engineering in Purdue University and appointment of Dr. P. N. Powers, of Clayton, Mo., who heads the Internuclear Company of Clayton, as head of the department and professor of nuclear engineering, has been announced by President F. L. Hovde following approval by the board of trustees. Dr. Powers also becomes associate director of the Engineering Experiment Station as the research expands in the nuclear field.

The new appointee who assumed his duties March 1, brings to the campus one of the nation's leading engineers and physicists in the field of nucleonics.

AIME Names Recipient of James Douglas Gold Medal

Dr. A. B. Kinzel, vice-president–research of Union Carbide Corporation, has been named by the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) for its James Douglas Gold Medal. Dr. Kinzel is president-elect of Engineers Joint Council, of which AIEE is a constituent society.

This distinction was conferred during the AIME annual meeting held in New York on February 14-18, 1960. Dr. Kinzel was selected ". . . for outstanding contributions and inspiring leadership in the field of electrolytic and electrothermic winning of nonferrous metals and for his notable administrative ability."

A member of AIME since 1926, he was president in 1958 and has been chairman of the Finance Committee. He was Howe Memorial Lecturer in 1952.

Dr. Kinzel is chairman of the Engineering and Industrial Research Division of the National Academy of Sciences–National Research Council.

The James Douglas Gold Medal was established in 1922 in honor of Dr. James Douglas, twice president of AIME. It recognizes distinguished achievement in nonferrous metallurgy, including both beneficiation of ores and alloying and utilization of nonferrous metals.

Dr. Kinzel was born in New York City in 1900. He received the degree of B.A. cum laude in mathematics from Columbia University in 1919, the B.S. degree in engineering from Massachusetts Institute of Technology (MIT) in 1921, and subsequently doctorates in metallurgical engineering and science from the University of Nancy in France. He was awarded the honorary degrees of doctor of engineering by New York University in 1955 and doctor of science by Clarkson College of Technology in 1957.

He joined Union Carbide in 1926, before which he was associated with General Electric Company and Henry Disston and Sons, Inc. He became vice-president–research for Union Carbide Corporation in 1955.

One of the country's leading research metallurgists, Dr. Kinzel pioneered in the theory of stainless steels, and theory and application of the structural low-alloy steels and new ferro-alloys. He is responsible for major advances in the welding and cutting of steel.

Subsequently, he spearheaded the research that led to the development of Union Carbide's process for making titanium metal. More than 40 patents have been issued in his name.

His extensive background in mathematics and physics, as well as in metallurgy, has been put to use in the field of nucleonics. He has served as consultant to various Atomic Energy Commision installations, including the Los Alamos, Oak Ridge, Argonne, Knolls, and Brookhaven Laboratories. As a member of the initial Manhattan District Committee for the World Control of Atomic Energy, he helped draft the classified report that was the working basis for the Lillienthal and Baruch plans. Presently he is a member of the Defense Science Board and a member of the Naval Research Advisory Committee of which he is a past chairman (1953-54). He is a member of the MIT Corporation and a Fellow of the New York Academy of Science.

Fabian Bachrach

A. B. Kinzel

Dr. Kinzel is coauthor of the Engineering Foundation's volumes on "Alloys of Iron and Chromium" and is the author and coauthor of more than 60 technical papers. He is a Samuel Wylie Miller medalist of the American Welding Society, a James Turner Morehead medalist of the International Acetylene Association, and a Stevens Institute of Technology powder metallurgy medalist.

Dr. Kinzel is a member of many engineering societies and is past chairman of the Engineering Foundation Board, the Welding Research Council, and former vice-president of the International Institute of Welding.

AIME also awarded honorary membership to five men of outstanding achievement:

Andrew Fletcher of New York, N. Y., president of the St. Joseph Lead Company; J. M. Lovejoy of New York, consultant on oil investments; H. D. Smith of New York, former vice-president of Newmont Mining Corporation; Wilford Sykes (AM '09, M '12, F '14, Member for Life) of San Francisco, Calif., former president of Inland Steel Company; and W. E. Wrather of Washington, D. C., former director of the U. S. Geological Survey.

Mr. Sykes was cited for ". . . distinguished service to the steel industry, particularly as a pioneer in the development of electrical equipment for steel mills." He holds the Washington Award of which AIEE is a co-sponsor.

Engineering Guidance for High School Students

There is no need to remind engineers of the importance of technology to our economy. It is likewise obvious to engineers that continuation of our technical progress will require a steady and increasing flow of engineering graduates into the profession.

The first step in securing the necessary growth in our engineering population is to interest qualified high school students in engineering as a career. Thousands of engineers are giving unstintingly of their time to this effort. The help of more engineers is needed to further develop and expand guidance programs.

Individuals and local groups of engineers, at times, have undertaken engineering guidance work unaware of the co-ordinative role played in this field by the Guidance Committee of the Engineers' Council for Professional Development (ECPD). Unco-ordinated guidance effort in an area by several different groups usually results in a duplication in school contacts and uneven standards in the conduct of the work. The co-operation of school authorities cannot be maintained in the absence of a unified approach.

Some years ago, ECPD State Committees were organized to co-ordinate the efforts of engineering groups engaged in guidance activity, to interest additional individuals or groups in guidance in order to obtain nation-wide coverage of public, private, and parochial schools, and to promote the adoption of standards for the conduct of the work.

These State Committees are grouped into eight Regions for administrative purposes. The Region chairmen and representatives of the eight societies included in the ECPD Council constitute the National Guidance Committee.

The State Committees work directly with the high schools, counseling students to study mathematics and science and urging those with the necessary aptitude to consider a career in engineering.

Interest in engineering is aroused through a wide variety of projects and programs. Talks and panel presentations before student groups and assemblies, and before teachers, vocational counselors and parents have been suggested. Typical projects include inspection trips and the showing of appropriate technical films, promotion of high school engineering clubs and science fairs, and individual counseling.

The National Guidance Committee supports the work of the State Committees through two annual mailings to the country's 30,000 high schools, providing literature, and calling the attention of the superintendent, principals, and counselors to the guidance services available to them from the State Committees.

This nation-wide effort requires the assistance of large numbers of engineers. Many are participating in ECPD co-ordinated guidance work through a committee of their local group. Persons who are interested in engaging in this activity should first find out what the local group is doing in this field. Many groups have a representative on their State ECPD Guidance Committee and others are indirectly represented through membership in local councils of engineering societies. In the latter arrangement, the Council chairman is frequently a member of the State ECPD Committee. You may prefer to volunteer your services as a speaker directly to your State ECPD chairman.

There is a need and place for all engineers interested in engineering guidance work. A roster of ECPD State and Region chairmen follows:

Region I

Chairman: Prof. E. T. Donovan, mechanical engineering department, University of New Hampshire, Durham, N. H.

Connecticut. George Sutherland, Park Road, Woodbury, Conn.
Maine. Dean W. S. Evans, School of Engineering, University of Maine, Orono, Maine.
Massachusetts. R. T. Bogan, Monsanto Chemical Company, Springfield 2, Mass.
New Hampshire. Dean R. N. Faiman, College of Technology, University of New Hampshire, Durham, N. H.
Rhode Island. R. H. Stockard, director of placement, University of Rhode Island, Kingston, R. I.
Vermont. E. R. McKee, dean of engineering, University of Vermont, Burlington, Vt.

Region II

Chairman: Prof. H. F. Roemmele, placement officer, Cooper Union, Cooper Square, New York 3, N. Y.

New Jersey. T. L. Dinsmore, McGraw Edison Company, Watchung Ave., West Orange, N. J.
New York. E. A. Hilbert, General Electric Company, Schenectady 5, N. Y.

Co-Chairman. Charles Miller, Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.

Region III

Chairman: D. M. Seeley, U. S. Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Delaware. T. F. Degnan, E. I. duPont deNemours & Co., Inc. Louviers Building, Wilmington 98, Del.
District of Columbia. R. I. Cole, Melpar, Inc., 3000 Arlington Boulevard, Falls Church, Va.
Maryland. J. B. Gillett of Whitman, Requardt, and Associates, 1304 St. Paul St., Baltimore 2, Md.
Pennsylvania. G. M. Colburn, U. S. Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Region IV

Chairman: J. H. Lampe, dean of engineering, North Carolina State College, Raleigh, N. C.

Alabama. Dean J. R. Cudworth, College of Engineering, University of Alabama, University, Ala.
Florida. J. C. Reed, head, department of mechanical engineering, University of Florida, Gainesville, Fla.
Georgia. Dr. R. T. Staton, assistant dean of engineering, Georgia Institute of Technology, Atlanta 13, Ga.
Mississippi. Dr. F. H. Kellogg, dean of engineering, University of Mississippi, University, Miss.
North Carolina. J. K. Whitfield, professor of mechanical engineering, North Carolina State College, Raleigh, N. C.
South Carolina. Dr. H. von N. Flinsch, head, department of civil engineering, University of South Carolina, Columbia, S. C.
Tennessee. Prof. J. M. Henderson, director, School of Engineering, Tennessee Polytechnic Institute, Cookeville, Tenn.
Virginia. J. W. Whittemore, dean, engineering and architecture, Virginia Polytechnic Institute, Blacksburg, Va.

Region V

Chairman: G. P. O'Connell, General Motors Corporation, 3044 West Grand Boulevard, Detroit 2, Mich.

Indiana. C. W. Kronmiller, General Electric Company, 1635 Broadway, Fort Wayne 2, Ind.
Kentucky. Dean R. E. Shaver, College of Engineering, University of Kentucky, Lexington, Ky.
Michigan. Glenn Coley, Engineering Society of Detroit, 100 Farnsworth, Detroit 2, Mich.
Ohio. R. P. Stock, B. F. Goodrich Company, Akron 18, Ohio
West Virginia. R. B. Johnston, P. O. Box 249, Charleston 21, W. Va.

Region VI

Chairman: Dean A. B. Drought, engineering department, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Illinois. J. E. Harrington, 910 Lake Shore Drive, Chicago 11, Ill.
Iowa. G. F. Fisher, Stanley Engineering Company, Hershey Building, Muscatine, Iowa.
Minnesota. L. A. Griffith, Minneapolis-Honeywell Regulator Company, 2835 Nicollet Ave., Minneapolis 8, Minn.
Missouri. W. E. Bryan, secretary, Engineers Club of St. Louis, 4229 Lindell Boulevard, St. Louis 8, Mo.
Nebraska. Dr. Mark Hobson, dean, College of Engineering and Architecture, University of Nebraska, Lincoln, Nebr.
North Dakota. Prof. T. F. Peterson, Training University of North Dakota, 2305 Seventh Ave., North, Grand Forks, N. Dak.
South Dakota. William Emerson, South Dakota Society of Engineers and Architects, Aberdeen, S. Dak.
Wisconsin. W. G. Murphy, College of Engineering, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Region VII

Chairman: Robert Matteson, chairman, California Research Corporation, Box 1627, Richmond, Calif.

Arizona. Americo Lazzari, Arizona Public Service Company, 4323 N. 14th Ave., Phoenix, Ariz.
California.
Northern. H. C. Ries, Shell Development Company, Emeryville, Calif.
Southern. Robert Milmoe, Bechtel Corporation, P. O. Box 58424, Los Angeles 58, Calif.
Idaho. Prof. D. H. Moser, head, engineering department, Northern Idaho Junior College, Coeur d'Alene, Idaho.
Montana. Dean E. W. Schilling, College of Engineering, Montana State College, Bozeman, Mont.
Nevada. Dean H. B. Blodgett, College of Engineering, University of Nevada, Reno, Nev.
Oregon. A. A. Osipovich, Professional Engineers of Oregon, 4303 S.E. Knapp St., Portland 6, Oreg.
Utah. Prof. G. K. Borg, head, civil engineering department, University of Utah, Salt Lake City, Utah.
Washington.
Eastern. Ralph Landerholm, Ken Woods & Associates, Hutton Building, Spokane, Wash.
Western. Prof. D. C. McNeese, general engineering department, University of Washington, Seattle 5, Wash.

Region VIII

Chairman: J. G. McGuire, assistant to dean of engineering, Agricultural and Mechanical College of Texas, College Station, Texas.

Arkansas. Prof. J. L. Imhoff, head, department of industrial engineering, University of Arkansas, Fayetteville, Ark.
Colorado. Ernest Dobrovolny, U. S. Geological Survey, Building 25, Denver Federal Center, Denver, Colo.
Kansas. K. E. Rose, head, department of mining and metallurgical engineering, University of Kansas, Lawrence, Kans.
Louisiana. W. C. Gaddy, Esso Standard Oil Company, Baton Rouge, La.
New Mexico. Dr. L. E. Bothell, Sandia Corporation, Sandia Base, Albuquerque, N. Mex.
Oklahoma. Dean M. R. Lohmann, College of Engineering, Oklahoma State University, Stillwater, Okla.
Texas. Col. T. C. Green, executive secretary, Texas State Board of Registration for Professional Engineers, 308 W. 15th St., Austin 1, Texas.
Wyoming. Prof. G. B. Mullens, civil and architectural engineering department, University of Wyoming, Laramie, Wyo.

Outside Continental United States

Canada. D. A. Young, chairman, Foundation of Canada Engineering Corporation, Ltd., 900 Sherbrooke St., W., Montreal, Que., Can.

Wear Your ◆ AIEE Badge

Papers Invited for NEC, Slated for October 10-12, 1960

The National Electronics Conference (NEC) will be held October 10-12, 1960, at the Sherman Hotel, Chicago, Ill.

Authors of papers have been invited to submit abstracts of 100 to 150 words for publication in the program and either a 400- to 500-word summary or the completed paper for review. These should be submitted to: Prof. T. F. Jones Jr., program chairman, NEC, School of Electrical Engineering, Purdue University, Lafayette, Ind.

Subject Areas

Technical areas typical of those covered at the conference include: adaptive servomechanisms, antennas and propagation, audio, circuit theory, communication systems, computers, information theory, instrumentation and telemetry, masers, microminiaturization, microwaves, millimeter waves, parametric amplifiers, plasma research, radar and radio navigation, radio astronomy, servomechanisms, signal-matched filters, solid-state circuits, solid-state devices and materials, space electronics—communications and navigation, television, transistors, and value engineering.

Officers Elected

Dr. L. W. Von Tersch, head of the electrical engineering department at Michigan State University, has been elected president of the NEC for 1960.

Other officers named are: Executive vice-president, J. J. Gershon, DeVry Technical Institute; secretary, J. H. Kogen, GPE controls, Inc.; treasurer, Dr. H. E. Ellithorn (AM '40, M '47), University of Notre Dame; assistant treasurer, R. J. Parent (AM '41, M '50), University of Wisconsin.

The newly-elected NEC chairman of the board is W. O. Swinyard, vice-president of Hazeltine Research, Inc., a past president of NEC.

Committee Chairmen

Committee chairmen elected are:

Arrangements, B. G. Griffith, Teletype Corporation; exhibits, J. S. Powers, Bell and Howell Company; fellowship award, O. I. Thompson, DeVry Technical Institute; finance policy, Dr. J. D. Ryder (AM '40, F '51), Michigan State University; housing, Juergen Roedel (AM, '50), Hallicrafters Company; international activities, G. E. Anner, University of Illinois; long-range planning, Dr. C. E. Barthel, Jr., Armour Research Foundation; NEC party, S. I. Cohn, Armour Research Foundation; 1959 *Proceedings*, C. H. Hoffman (AM '51, M '58), University of Notre Dame; 1960 *Proceedings*, Dr. T. L. Butler, Jr., University of Michigan; program, Dr. T. F. Jones, Jr., (M '58), Purdue University; registration, L. J. Murphy (AM '55), Illinois Bell Telephone Company; student activities, Dr. M. E. Van Valkenburg, University of Illinois.

A few of the outstanding activities of NEC include the annual Fellowship

Award, which has a value of $2,500 and is designed to assist worthy undergraduates to further their electronic training; the Annual Award, which honors an author who participated in the program of the preceding year and presented what was considered the finest paper; and the Award of Merit, which is presented from time to time and honors the author of a particularly influential paper given at any prior conference. The Award of Merit includes a check in the amount of $750. The last such award was presented to Dr. L. N. Brillouin, the engineer-scientist, for his paper on "A Theorem of Larmor and its Importance for Electrons in Magnetic Fields."

Sponsors

NEC sponsors include the AIEE, Illinois Institute of Technology, IRE, Northwestern University, and the University of Illinois. Participants are Michigan, Michigan State, Notre Dame, Purdue, Wayne State, and Wisconsin Universities; Electronic Industries Association; and the Society of Motion Picture and Television Engineers.

AIEE PERSONALITIES

R. H. Barclay (AM '14, F '28, Member for Life) received the alumni citation of Washington University, St. Louis, Mo., on Sunday, February 21, 1960, at the University's Founders' Day Program. The Alumni Citation Committee and the Washington University board of directors chose Mr. Barclay as one of the 12 distinguished alumni to receive the alumni citation in recognition of outstanding achievements and services which reflect honor upon the University. A consulting engineer, Mr. Barclay served on the AIEE Board of Examiners (1943-59, chairman 1946-48).

C. H. Bartlett (AM '52, M '59), vice-president of the Westinghouse Electric Corporation, has been assigned as deputy general manager of the East Pittsburgh, Pa., division. He was formerly assistant to the vice-president and general manager of apparatus products. **J. M. Wallace** (AM '41, M '48), formerly manager of the Westinghouse Meter Division in Newark, N. J., has been appointed assistant manager of the Manufacturing and Repair Divisions with headquarters in Pittsburgh. In mid-1960, upon the retirement of the manager of the latter two divisions, Mr. Wallace will become manager. **A. J. Petzinger** (AM '36, F '57) has succeeded Mr. Wallace as manager of the Meter Division. He was formerly manager of the instrument department of that division. Mr. Wallace is a member of the AIEE Prize Awards Committee (1959-60), and Mr. Petzinger of the Indicating and Integrating Instruments Committee (1956-60).

In the new reorganization plan of the National Electrical Manufacturers Association, the following planning committee members were named: **C. H. Bartlett** (AM '52, M '59), vice-president, apparatus products, Westinghouse Electric Corporation; **J. J. Mellon** (M '45), chief engineer, Allen-Bradley Company; and **F. H. Roby** (AM '37, M '41), executive vice-president, Federal Pacific Electric Company.

Henri Busignies (M '56, F '59), former president of International Telephone and Telegraph Corporation Laboratories, New York, N. Y., has been named vice-president and general technical director of the parent company.

Joseph Carlstein (AM '52) has been named chief engineer of the Norden Division's Ketay department at Commack, L. I., N. Y. He was formerly supervisor of development engineering.

J. B. Colson (AM '57) has accepted a position as an instrument development engineer with the Reactor Physics and Engineering Branch of Phillips Petroleum Company.

William Deans (AM '16, F '30, Member for Life), former associate of **Thomas A. Edison** (Honorary Member '28) and pioneer in circuit breaker design, retired from active service with I-T-E Circuit Breaker Company, Philadelphia, Pa. A vice-president on retirement, he had been associated with I-T-E since 1933, when he joined the firm as chief engineer. In 1950, he was named vice-president in charge of engineering—the company's first such post—and since 1956 has served as vice-president. Prior to joining I-T-E, Mr. Deans was general manager of Sundh Electric Company, Newark, N. J., where he had started as chief engineer. Before this, he had been on the personal staff of Thomas A. Edison. After graduation from Cornell University, he had served on the Cornell faculty prior to his joining the Edison staff. Mr. Deans' significant contributions to the electrical industry center primarily in the area of electric buses and bus structures used to carry high power at high voltages. He also contributed substantially to furthering the circuit breaker art, with which he pioneered in employing mathematics to predict behavior of natural phenomena. He serves on the AIEE Industrial and Commercial Power Systems Committee (1954-60).

William Deans

E. F. Dissmeyer (M '36, F '47), in charge of production and transmission for the Ohio Edison Company, Akron, Ohio, has been elected a vice-president of the company, a new office created by Edison's board of directors. He had been placed in charge of production and transmission in January 1959.

W. J. Feahr (AM '54) of Cleveland, Ohio, has been named divisional manager of the Great Lakes Division of Crouse-Hinds Company, Cleveland. He joined the organization in 1948 as a product engineer.

R. A. Franklin (AM '54) has been appointed manager of engineering of Stromberg-Carlson in San Diego, Calif. He was formerly regional manager of Radiation Inc., Albuquerque, N. Mex.

L. C. Holmes (AM '31, F '51), formerly director of research for the Stromberg-Carlson Division of General Dynamics Corporation, has been appointed director of engineering operations. He has been vice-president of AIEE Empire District No. 1 (1958-60) and is a member of the AIEE Research Committee (1958-60) and Recognition Awards Committee (1959-62).

E. L. Horne (AM '50) has been named Milwaukee Wis., area electrical products representative for the Electrical Autolite Company. He had been a member of the electrical controls department of Allis-Chalmers in Milwaukee.

J. G. Kirwan (AM '41, M '49) has been appointed to the newly created position of marketing manager for Electro-Measurements, Inc., Portland, Oreg. He was formerly district engineer for Westinghouse Electric Corporation in Portland. He is a member of the AIEE Registration of Engineers Committee (1954-60).

J. J. Kovski (AM '41, M '50) has been appointed acting manager of Technical Services of Melpar, Inc., Falls Church, Va., to direct the work of the reliability and specification analysis groups at division level and will report to the chief engineer. Melpar is a subsidiary of Westinghouse Air Brake Company.

L. J. Linde (AM '39, F '51), project manager of C-Stellarator Associates, a combination of the engineering and scientific staff of the Allis-Chalmers Manufacturing Company and the Radio Corporation of America, is presently in charge of designing and building the C-Stellarator facility at Princeton for advanced research into controlled thermonuclear reactions. He served on the AIEE Nucleonics Committee (1959-60).

K. S. I. Lindell (AM '26, M '54) has become vice-president of research and engineering, S&C Electric Company, Chicago, Ill., due to the separation of the company's research and engineering functions.

C. H. Baker (M '49) was named engineering director; **J. J. Mikos** (AM '40, M '46), research manager; and **H. H. Fahnoe** (AM '35, M '49), engineering manager. Mr. Baker has served on the AIEE Switchgear Committee (1952-60).

F. K. McCune

F. K. McCune (AM '33, F '49) has been elected vice-president–engineering services for General Electric Company (GE). In his new post, Mr. McCune will direct the work of some 13,500 engineers. In addition, he will be a member of the company's executive office, GE's senior management body. He began his career with the company in 1928. In February 1959, he was named to head atomic business development for the company's marketing services. He served on the AIEE Management Committee (1951-57) chairman 1953-55).

W. J. Miller (AM '19, F '43, Member for Life) has retired from teaching at the University of Alabama where he had been head of the department of electrical engineering since 1936. He was vice-president of AIEE District 4 (1955-57) and has served as Technical Operations Department representative for District 13 (1958-60).

S. O. M. Osthagen (AM '47, M '54) has been appointed manager of utility sales, Boston District, Allis-Chalmers Manufacturing Company. **C. R. Carlisle** (AM '55) was named manager of industrial sales, Boston District. Mr. Osthagen was named manager in 1954 of the Providence District territory which is now being served by the Boston District. He was vice-president of AIEE District 12 (1957-59) and is an AIEE director (1959-63). Mr. Carlisle had been a sales representative in the Boston District.

I-T-E Circuit Breaker Company of Philadelphia, Pa., has moved **E. B. Rietz** (AM '42, M '52) from a position on the corporate staff of the vice-president of engineering to the newly created position of manager of engineering of the Kelman Power Circuit Breaker Division. Mr. Rietz has been serving as a power circuit breaker engineering consultant to Kelman Division. Mr. Rietz is a member of the AIEE Switchgear Committee (1959-60). **H. H. Mitchell** (AM '44, M '50), formerly chief engineer for Kelman, has been assigned responsibilities as manager of engineering administration. **G. H. Moorhead, Jr.** (AM '41, M '50) has taken over as supervisor of Kelman's new high-voltage development laboratory.

R. G. Rincliffe (AM '42, M '57), president of the Philadelphia Electric Company, Philadelphia, Pa., has been elected president of the Association of Edison Illuminating Companies. Mr. Rincliffe, who had been serving as vice-president of the association, was elevated to the top post during the 75th annual meeting of the organization at Boca Raton, Fla.

S. J. Rosch (AM '15, Member for Life) has retired from active duty with Anaconda Wire and Cable Company after 48 years of association with the electrical wire and cable industry. Forty of these years were with Anaconda Wire and Cable and its predecessors. As consulting cable engineer for Anaconda Wire and Cable, he was "ambassador-at-large," providing customers with assistance and counsel. He has been president and is a life member of the Insulated Power Cable Engineers Association. His invention for applying carbon black tapes to electrical conductors is said to be one of the outstanding developments for improving the serviceability and life of paper-lead power cables. His early days in the wire and cable industry go back to 1910 when he started work in the Safety Insulated Wire and Cable Company in New Jersey. In 1919, he became assistant superintendent of the National Conduit and Cable Company at Hastings-on-Hudson, N. Y. He joined the American Brass Company when it acquired National Conduit in 1923, and became associated with Anaconda Wire and Cable Company when it took over operations at Hastings in 1930. At Hastings, he served as manager of insulated product development until 1948 when he was appointed consulting cable engineer, a position he handled until his retirement. Mr. Rosch is a member of the AIEE Insulated Conductors Committee (1951-60) and Chemical Industry Committee (1951-60).

L. L. Ruggles (M '34, F '50), chief telephone engineer for Automatic Electric Company, Northlake, Ill., has retired after almost 41 years of service. Fellow employees honored his retirement with a banquet held at the Elmhurst Country Club, November 30, 1959, during which he was presented with a plaque which commemorated his outstanding service to the company. Holder of 13 United States patents, Mr. Ruggles is credited with important developments in automatic switching systems during his career with the manufacturing firm, a subsidiary of General Telephone & Electronics. In 1954, he was the recipient of the Talbot G. Martin Award presented by the Strowger Automatic Club, an employee organization, for his outstanding contributions to the art and science of communications. He is a member of Tau Beta Pi, Eta Kappa Nu, and the Western Society of Engineers.

T. L. Rundlett (AM '41, M '49) has joined Anderson Electric Corporation, Birmingham, Ala., as chief engineer. He was previously division engineering manager of Westinghouse Electric Corporation's Air Conditioning Division in Staunton, Va. He has served on the AIEE Domestic and Commercial Applications Committee (1957-60).

A. G. Schifino (AM '40) has resigned as vice-president and general manager of Stromberg-Carlson's Special Products Division and has joined the Rochester Radio Supply Company, Inc., Rochester, N. Y., as executive vice-president. He will continue to serve as a consultant to Stromberg-Carlson in the sound equipment field for an indefinite period.

W. G. Shepherd (M '51), head of the department of electrical engineering, University of Minnesota, Minneapolis, Minn., has been appointed director of the Institute of Radio Engineers for the 1960-62 term. Regional directors, elected for 1960-61, are as follows: **J. B. Russell, Jr.** (AM '34, F '51), manager, Electronics Laboratory, General Electric Company, Syracuse, N. Y., and **B. J. Dasher** (M '58), director, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga. Mr. Russell has served on the AIEE Basic Sciences Committee (1947-49, 1956-60) and Board of Examiners (1957-60).

M. T. Smith (AM '32, M '38), sales manager of the General Radio Company, West Concord, Mass., has been appointed director of sales. **W. R. Saylor** (AM '51), manager of the Los Angeles, Calif., General Radio district office, has been named sales manager to succeed Mr. Smith. After logging over 26,000 miles by air and 2,000 miles by car, **E. C. Starr** (M '29, F '41), chief engineer, Bonneville Power Administration (BPA), returned recently from a 5-weeks special United Nations assignment in India. Loaned by the Department of Interior as a consultant to the director of the UN Special Fund, he was asked to evaluate a grant-in-aid request to establish power research and mechanical engineering research institutes in India. Mr. Starr is an AIEE director (1958-62) and has served on the following AIEE Committees: Research (1941-43, 1955-60); Power Transmission and Distribution (1944-60); Nucleonics (1955-60); Professional Conduct (1956-60); Board of Directors (1958-62); Electrical Insulation (1957-60); Edison Medal (1958-60); Education (1958-60); and Constitution and Bylaws (1959-60).

A. D. Steele (AM '46) has been appointed product sales manager of the Minnesota Mining and Manufacturing Company.

M. C. Westrate (AM '37, F '58), an officer and director of Commonwealth Associates, Inc., Jackson, Mich., engineering affiliate of Commonwealth Services, Inc., has been elected a director of Commonwealth Services.

R. J. Wiseman (AM '16, F '27, Member for Life) has retired from active service in the Okonite Company, Passaic, N. J., but will continue to work for Okonite as cable consultant. Dr. Wiseman, who was associated with the company for 38 years, held the position of vice-president and chief en-

gineer at his retirement. Born in Cambridge, Mass., in 1890, he received his B.S. degree in 1912 from the Massachusetts Institute of Technology (MIT), and subsequently, in 1915, his doctorate in science. In the intervening years, he was an associate instructor at MIT and, prior to joining the research and engineering department of Western Union Telegraph Company, New York, N. Y., in 1917, continued his activities at MIT as a research assistant. From 1918 until his association with the Okonite Company in 1921, Dr. Wiseman served as a wire and cable engineer at the National Conduit and Cable Company. He was named chief engineer at Okonite in 1928 and was appointed vice-president in 1950. Dr. Wiseman is a member of the International Conference on Large Electric High Tension Systems and is the U. S. technical advisor on Committee 20, Electric Cables, of the International Electrotechnical Commission. He is a member of the Committee on Insulation for both the National Research Council and the American Society for Testing Materials. An active member of the Insulated Power Cable Engineers Association since 1925, he was elected president of the group for a 2-year term in 1939. In addition, Dr. Wiseman holds memberships in the Passaic, N. J., Engineering Society, the National Society of Professional Engineers, the New Jersey Society of Professional Engineers, the Montclair, N. J., Society of Engineers, and the Institution of Electrical Engineers of Great Britain. He is a member of the AIEE Research Committee (1931-39, 1959-60; Insulated Conductors Committee (1947-60); Edison Medal Committee (1956-61); and also served on the following AIEE Committees: Transmission and Distribution (1939-47, chairman 1945-47); Instruments and Measurements (1937-39); Applications to Marine Work, Marine Transportation (1937-43); Board of Examiners (1939-45); Standards (1945-46); Technical Program (1945-46); Award of Institute Prizes (1945-46); and Engineering Foundation Board (1955-58).

R. J. Wiseman

Alexander Zeitlin (M '44), president of the Engineering Supervision Company, was a guest lecturer in a graduate course on the management of engineering functions during the Spring semester at New York University's College of Engineering. His lecture was entitled, "Creating an Engineering Organization for the Heavy-Press Program of the U. S. Air Force." **L. L. Carter** (AM '29, F '38), chief engineer, Anaconda Wire and Cable Company, will lecture May 9, 1960, on "Decisions Preceding a New Wire and Cable Plant."

OBITUARIES

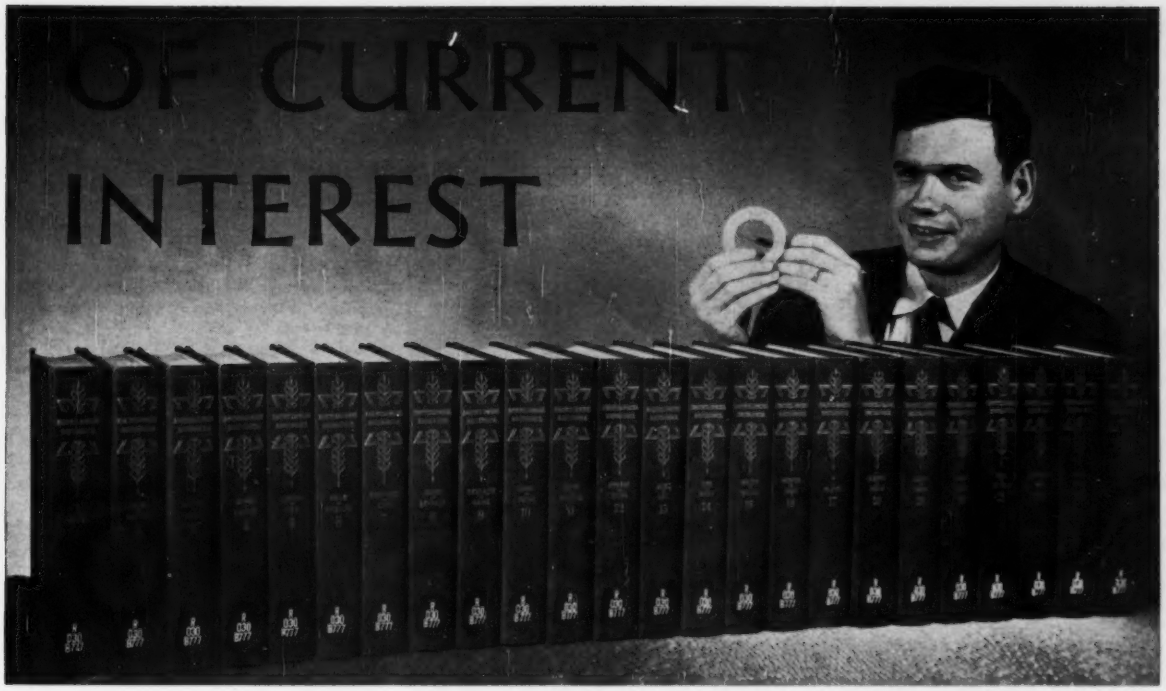
Claxton Edmonds Allen (AM '04, M '13, F '14, Member for Life), a former vice-president of the Westinghouse Electric and Manufacturing Company, died recently at the age of 78. Mr. Allen was born February 4, 1881, in Fluvanna County, Va. He graduated from Virginia Polytechnic Institute in 1901 with the B.S. degree in electrical engineering. In 1901, he entered the apprentice course of the General Electric Company at the Lynn, Mass., works. Two years later, he became the designer of a-c motors, transformers, and regulators in the a-c engineering department. He then entered the commercial department as a commercial engineer. In 1909, he joined Westinghouse in East Pittsburgh, Pa., as a commercial engineer in charge of transformer and regulator sales. In 1912, the scope of his work was increased to cover other apparatus, involving design as well as application. He was made assistant manager of the detail and supply department the following year. For a brief period in 1915, he was attached to the sales department of the New York District Office and then was made manager of the Supply Division and Central Station Division of the Chicago, Ill., office, a position he held until 1922 when he was appointed manager of the St. Louis, Mo., District Office. In 1930, he was elected a commercial vice-president of Westinghouse with headquarters in East Pittsburgh, Pa.

Fred Beatty (AM '37, M '44), a staff member of the electrical engineering department of the University of Colorado, Boulder, Colo., died recently. Mr. Beatty was born April 11, 1904, in Raymond, Ill. He received the B.S. degree in electrical engineering in 1926 from the Missouri School of Mines and the M.S. degree in 1934 from the Georgia Institute of Technology. During 1929-36, he was an instructor in electrical engineering at the Georgia School of Technology, and in 1936 became an instructor of electrical engineering at the University of Kentucky. In 1938, he went to the Colorado State College as associate professor of electrical engineering, and later taught at the University of Colorado. For several summers, he was employed by the Public Service Company of Colorado. He was a member of Tau Beta Pi, Sigma Tau, and the American Society for Engineering Education.

Ralph Cowan Browne (F '28, Member for Life), inventor, electrical engineer, and roentgenologist, of Salem, Mass., died recently. He was born November 15, 1880, in Salem, Mass. Mr. Browne was the inventor of the mine apparatus that was credited with turning the tide of battle in World War I and bringing the war to a halt. When Mr. Browne's invention was perfected, the United States had a device that multiplied by three the power of the mine previously used. The theory of the mine not only increased its potential power but practically eliminated the possibility of any failure of the mine to perform its mission. Attached to the mine was a long wire antenna which would form a circuit that exploded the mine's contents when the antenna came into contact with a metal other than copper. The ocean water provided the battery liquid, and the contact with the hull of a submarine or any vessel formed a circuit which caused the explosion. Mr. Browne carried on an extensive practice as a roentgenologist for many years.

George Edgar Goldthwaite (AM '17, M '31, Member for Life), consulting engineer, New York, N. Y., died recently at the age of 70. Mr. Goldthwaite was born October 18, 1889, in Marion, Ind. He graduated from Purdue University in 1911 with the B.S. degree in electrical engineering. In 1911-12, he took the Westinghouse graduate student course at East Pittsburgh, Pa. During 1912-14, he was employed by the Pittsburgh Railway Company. He was power director for the Norfolk and Western Railway Company in 1914-16. At various intervals during 1916-20, he was engineer and foreman on electrical construction projects for Lewis and Roth Company, Philadelphia, Pa. He was associate editor in 1916-17 for the *Railway Electrical Engineer* and *Railway Age Gazette*. During World War I, he was a first lieutenant, pilot, and flight commander in the 24th Aero Squadron. After the war, he was associated with Milo R. Maltbie, in 1919-29, in public utility work, which related to engineering, accounting investigations, and appraisals. In 1930, he became a member of the firm of Hine, Goldthwaite and Mylott (later Hine and Goldthwaite), engineers and accountants, specializing in public utility work.

George Marvin Tatum (AM '40, M '46), chief engineer, Virginia Electric & Power Company, Richmond, Va., died recently. He was born October 31, 1901, in Marlboro County, S. C. In 1924, he received the degrees of civil engineering and mechanical engineering from the University of Virginia. He did land and topographic surveying during the Summer of 1924 and then was surveyor for one year in the City of Staunton, Va. He was an inspector during 1925-26 in the reconstruction of the water supply dam. Mr. Tatum was employed by the Virginia Public Service Company as a field engineer in 1926-28 when he surveyed transmission lines and substations. He became draftsman and design engineer of the company in 1928, a position he held until 1931. He held the position of engineer for the company during 1931-39 and in 1939 became supervisor of system operation. When the Virginia Public Service Company became the Virginia Electric & Power Company in 1944, he became the company's superintendent of operation, Western Division, Charlottesville, Va. In 1946, he was assigned to the supervision of maintenance and loading of electric equipment and transmission lines. He served on the following AIEE Committees: Power Generation (1946-50), System Engineering (1949-53), and Switchgear (1956-59).



▲ *The Enclopedia Britannica—all 24 volumes of it—could, in principle, be recorded on the reel of tape held above by Dr. W. E. Glenn of the General Electric Research Laboratory. By means of thermoplastic recording, invented by Dr. Glenn, this information could be recorded at the rate of one volume per minute.*

Thermoplastic Recording System Has Many Possible Applications

A NEW RECORDING SYSTEM was described recently by General Electric (GE) scientists. Called thermoplastic recording, or TPR, "the new system, which is still in development, combines the processing speed and much of the versatility of magnetic recording and the storage capacity of photography, and it offers some advantages over both of these recording systems," according to Dr. Guy Suits, GE vice-president and director of research.

"Thermoplastic recording can already concentrate 100 times as much information in a given space as can magnetic recording, and it has the potential for still greater concentration. Like photography, TPR possesses the advantage of almost instantaneous recording, and will produce pictures either in color or black-and-white, but it does not require the chemical processing needed by photographic film, and can be erased and reused as desired."

Thermoplastic recording was invented by Dr. W. E. Glenn, physicist, of the GE Research Laboratory. It uses entirely new recording and play-back techniques, the company announced.

"Although TPR is at present in a developmental stage," Dr. Suits said, "we believe that it will add a most useful new capability in the field of information storage.

"Modern civilization, in general, and modern machines, in particular, are accumulating information so rapidly that information storage density expressed as bits of information per gram, or per cubic centimeter, or per square centimeter, has become an ever more critical index of information storage systems. In information processing machinery, the ability to store information rapidly, and to erase the record, or to project it as an image, are also important characteristics of the storage means. TPR, because of its combination of attractive characteristics and capabilities, would lend itself most effectively to advanced electronic systems for information handling," Dr. Suits added.

G. L. Haller, vice-president and general manager of the Defense Electronics Division, pointed out some nonclassified military applications being made at the company's Electronics Laboratory in Syracuse, N.Y. "Because of its wide-band, high-density recording, and direct read-out capabilities, a multitude of military applications exist for such a versatile display device in such areas as radar and infrared detection, electronic countermeasures, missile guidance, and military communications."

"In addition," according to Dr. Haller, "TPR is a 'natural' for military aerial reconnaissance and recording cameras. The instantaneous monitoring or read-out that TPR can provide is an obvious advantage; it provides on-the-spot evaluation of results so that retakes can be made if necessary. Information so obtained can also be disseminated without processing delays."

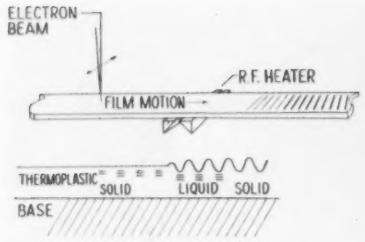
Dr. Haller also pointed out that the high-density storage and reusability features of TPR will make it especially important in satellites and space vehicles where size and weight are critical factors. "The usefulness of a satellite is proportional to the amount of information it can gather and transmit to earth," he observed. "At present, satellites can be assigned only simple tasks, but with TPR they may be assigned such complex duties as reporting the world's weather or global surveillance."

How System Works

Dr. Glenn described the technical details of thermoplastic recording as follows.

The recording is made in the form of small ripples on the surface of a plastic film. The ripples are formed by means of an electron beam, which scans the surface of the film. The recorder has an electrical input similar to a magnetic tape recorder, and an image output that is similar to photographic film. The latter can be changed to an electrical output signal by standard techniques.

The thermoplastic film has a base that



MECHANISM for thermoplastic recording (top), and cross-section of TPR tape (bottom).

is similar to the standard moving-picture film base. On top of this is a transparent conducting coating, and on top of the transparent coating there is a thin coating of thermoplastic material. This material will melt if it is raised to a fairly high temperature.

The surface of the thermoplastic is charged with an electron beam in a pattern like a television-type raster that corresponds to the pattern of ripples that is to form the image. As the film moves on over a pair of r-f electrodes, a current is induced in the transparent conducting coating, which heats the film to between 120 to 160 F so that the thermoplastic coating melts. The charges are attracted to the transparent conducting coating and depress the surface of the thermoplastic. After the surface has been deformed by the charges, the film is then allowed to cool; this freezes the ripple pattern in place.

In order to erase the information, the thermoplastic is heated again to a higher temperature, so that the charges leak away and surface tension smooths the surface back out to its original state. The film is then reusable.

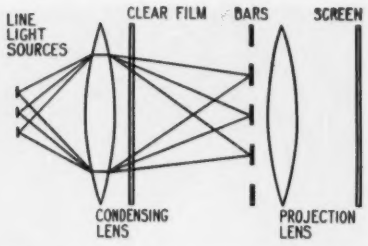
The accompanying photograph and schematic show a recording machine that records on thermoplastic film in this way. The film, of course, must be handled in

EACH FRAME of the thermoplastic record is less than 1/4 inch wide and fits easily inside a paper clip. The image is recorded in the form of microscopic indentations, but when ordinary light strikes the thermoplastic record at an angle, the image can be seen with the naked eye.

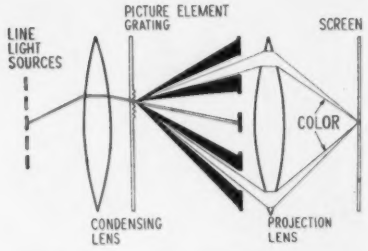
a vacuum, since the electron gun has to work in a vacuum. It takes only about one minute to pump the machine down from atmospheric pressure to a vacuum low enough for effective operation, about 0.1μ.

The signal input, in this recorder, is simply the intermediate-frequency signal out of a black-and-white television set, at about 1-volt level. If the images are to be recorded in color, another signal has to be added to another electrode, also at about a 1-volt level.

At first thought, it might seem difficult to use ripples on the surface of the film in order to produce an image. In projecting black and white, this is simply a modification of a Schlierien optical system; in color, it is necessary to use a special optical system invented some years ago.



PROJECTION SYSTEM suitable for TPR (with no ripples on film; ripples would permit light to pass between bars, creating an image on the screen).

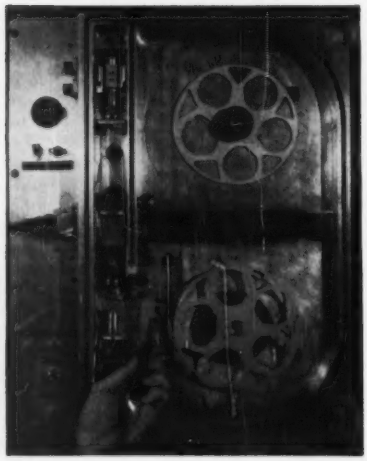


COLOR PROJECTION using TPR system.

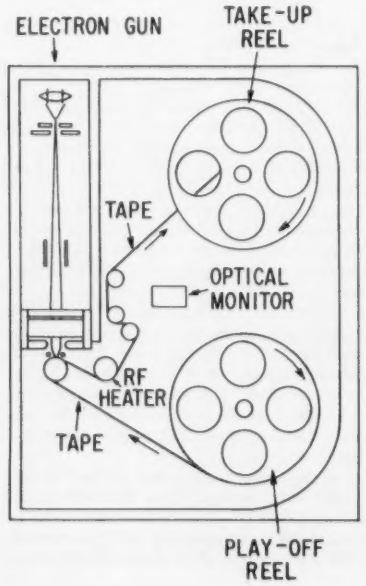
A standard projector has a plane light source, a condensing lens, and a projection lens. The light source is imaged on the projection lens by means of a condensing lens, and the projection lens images the slide to be projected on the screen.

If this is modified as shown in the accompanying diagram, so that instead of using a plane light source we use line light sources, and image these on a set of bars in front of the projection lens, no light will get through to the screen. If, however, there are ripples on the surface of the film at any particular point, these will scatter light through the bar system. Thus, the bar system acts somewhat like a shutter that allows light to pass wherever there is a ripple on the film. Whenever light passes through the projection lens, it images the ripple on the screen as a white spot. It is possible, for example, to take a clear slide that simply has ripples on the surface, put it in the projector, and have it appear as a black-and-white picture on the screen.

This system can be modified so that it can be used to produce color pictures. Each picture element has in it a set of ripples that form a little diffraction grating. The light that is diffracted by this grating forms a spectrum on each side of the central beam. The slots are made small enough so that only one color from the spectrum gets through to the projection lens. Since the projection lens can receive only one color of the spectrum, the spot that appears on the screen will appear in a single color. If the spot is to appear in another color, the spacing of the grating is changed so that a different part of the spectrum gets through the slot. In order to produce a color that is formed by a superposition of two or more



THERMOPLASTIC RECORDER (above). The thermoplastic tape moves from the play-off reel (bottom), past an electron gun, a heating unit, and an optical monitor to the take-up reel (top). *Right:* Schematic of recorder.



colors, the gratings in this spot are superimposed and the superposition of the colors results.

The film used in the present stage of development is the size of standard 16-mm film. The larger-size recordings use half the width of the film—the images are actually 5 mm wide—and the film runs at 10 inches a second. We are also recording with full resolution at half this picture size, so that the width of the track on the film is 0.1 inch wide, with the film running 5 inches a second. In the latter case, this is the width of a half-track of standard audio magnetic tape.

The film is run at only 5 inches a second rather than at the 7½ inches a second used in audio recording tape. This is true, despite the fact that video recording requires approximately 100 to 150 times the density of information that is ordinarily required by audio. We are thus doing more than 100 times the work that an audio tape recorder does.

Radiation Detector Useful in Space Exploration and Other Areas

VAST unprobed secrets of nuclear forces are now being uncovered by means of a "solid-state ionization chamber" smaller than the head of a pin, a scientist of Hughes Aircraft Company revealed recently.

The new device has important applications in space exploration, military uses, nuclear power control, cancer treatment, industrial processes, basic nuclear research, and other fields. It is actually an innovational radiation detector developed and produced by a team of nuclear physicists and solid-state physicists in Hughes laboratories at Los Angeles and Newport Beach, Calif.

Fields of Application

"The value of the Hughes detector lies in its ability to make measurements that up to now simply could not be made," Dr. S. S. Friedland said. "It measures the number and energy of atomic particles traveling at speeds faster than man can comprehend. It performs with far greater effectiveness than earlier detectors, is far less cumbersome, and costs less.

"The detector is essentially a slice of 'doped' silicon so thin as to be barely discernible to the eye. When struck by a charged nuclear particle it emits a pulse which can be measured and analyzed, providing us with information we need to know and often could not obtain before."

Dr. Friedland set forth six applications of the detector which he described as "either immediate or certain for the near future." They are:

1. *Space exploration:* A 3-dimensional package containing hundreds or even thousands of detectors, propelled hundreds of miles into space to transmit back to earth precise measurements of cosmic rays and the limits and nature of the Van Allen radiation belt.

2. *Military uses:* A simple, rugged device supplying field troops with instant information on radioactivity in their immediate area. Other purposes for detection and control of a classified nature.

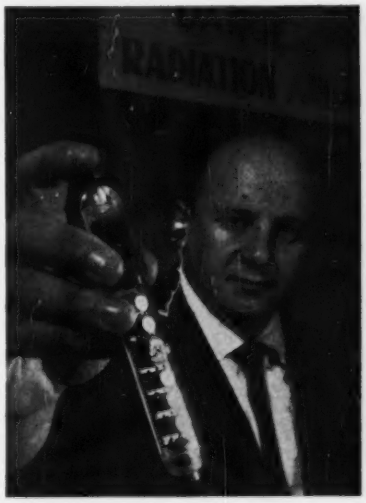
3. *Nuclear power control:* Instrumentation which will provide rapid response to changes and accurate measurement of radiation level in nuclear reactors.

4. *Cancer Treatment:* Measurement and control of radiation therapy (with precision far surpassing that previously achieved) in the destruction of malignant tissue. (The detector has many other medical uses.)

5. *Industrial process control:* Flow measurement, thickness gauging, liquid level measurement, oil well logging—all with greater accuracy, less hazard and greater speed, and all with reduced use of radioactive material.

6. *Basic physical research:* Determination of location, time, and energy of nuclear particles in laboratory experiments.

Dr. Friedland said the Hughes detector embodies several major advances over earlier detectors: it is so small it can be packaged in the tip of a hypodermic



'ALPHA CIGAR' is the term applied to this stogie-like tube containing a radiation detector, battery, and amplifier all in one small package, held by Dr. S. S. Friedland, one of Hughes Aircraft Company's scientists who developed the device. In its cigar-sized casing, a tiny "solid-state ionization chamber," no bigger than the head of a pin, has valuable military and industrial advantages as a radiation detector. The detector also has important uses in space exploration, medical research and treatment, and basic physical research.

Future Meetings of Other Societies

5th National Electrical Industries Show, Mar. 6-9, Coliseum, New York, N.Y. H. R. Meyer, American Electrical Industries Exposition, Inc., 550 Fifth Ave., New York 36, N.Y.

Conference on the Mechanical Properties of Engineering Ceramics, Mar. 9-11, North Carolina State College, Raleigh, N.C.

IAS, National Flight Propulsion Meeting, Mar. 10-11, *(classified),* Cleveland, Ohio. IAS, 2 E. 64th St., New York 21, N.Y.

NACE, 16th Annual Conference & Corrosion Show, Mar. 15-17, Dallas, Texas. R. W. Huff, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas.

NEMA, 1st National Electric House Heating Exposition, Mar. 21-23, Sherman Hotel, Chicago, Ill. R. D. Smith, NEMA House Heating Equipment Section, 155 E. 44th St., New York 17, N.Y.

Southeastern Electric Exchange, Annual Conference, Mar. 21-23, Boca Raton Hotel & Club, Boca Raton, Fla.

Institute of Radio Engineers

International Convention, Mar. 21-24, Waldorf-Astoria Hotel & Coliseum, New York, N.Y. E. K. Gannett, IRE, 1 E. 79th St., New York 21, N.Y.

1st Annual Symposium on Human Factors in Electronics, Mar. 24-25, New York, N. Y. R. R. Riesz, Papers Procurement Committee, c/o Bell Telephone Laboratories, Murray Hill, N.J.

10th biennial Electrical Industry Show & 1st Lighting Exposition, Mar. 23-26, Shrine Exposition Hall, Los Angeles, Calif. F. J. Tabery, 3443 South Hill St., Los Angeles 7, Calif.

Gas Appliance Manufacturers Association, Annual Meeting Mar. 30-Apr. 1 The Greenbrier, White Sulphur Springs, West Va.

ASME, Textile Engineering Conference, Mar. 31–Apr. 1, North Carolina State College, Raleigh, N.C.

Overseas

Electrical Engineers ASEE, 9th National Exhibition, Apr. 5-9, Earls Court, London, England. Electrical Engineers ASEE, Exhibition Ltd., Museum House, Museum St., London, W.C.I.

Industrial Latin American Partnership Exhibition, Apr. 1960-Oct. 1961, Parque Ibirapuera, Sao Paulo, Brazil, E. L. Neville, ILAPE Representative, 60 E. 42 St., New York 17, N. Y.

Conference on Automatic Computing and Data Processing in Australia, May 24-27, Univ. of Sydney and Univ. of New South Wales, Australia. C.H.D. Harper, Australian Natl. Committee on Computation and Automatic Control, The Institution of Engineers, Science House, 157 Gloucester St., Sydney, Australia.

8th International Automobile Technical Congress, May 9-13, The Hague, Netherlands. General Secretariat, 14, Burgemeester de Monchyplein, The Hague, Netherlands.

International Congress on Microwave Tubes, June 7-11, Munich, Germany. R. D. Paine, Jr., National Science Foundation, Washington 25, D.C.

International Conference on Large Electric Systems (CIGRE), 18th Convention, June 15-25, 112 Boulevard Haussmann, Paris 8, France.

needle: it requires no cumbersome power pack since it operates at very low voltage; it can pick up particles 1,000 times faster than previous detectors could.

Fast, Rugged, and Cheap

According to Dr. Friedland, "it is so accurate it can analyze the energy of particles to less than one-half of one per cent error, a performance which can be matched only with complicated equipment costing many thousands of dollars; yet the new detector costs less than dinner and two on the aisle."

It was stated that although the detector is ordinarily tiny, it can be made larger for alpha particle detection in low radiation level areas.

Today's methods of measuring the speed, direction, nature, and energy of cosmic (and other) outer space radiation were compared to the new possibilities using the Hughes detector.

"Today we use photographic plates inserted in the nose cone of a missile," he explained. "Rays and particles penetrate the film and define their courses through the layers. But you have still got to recover the nose cone (if you can!) containing the film emulsion to develop it, then spend weeks, even months, extracting the data from the plates.

"If we employed a 3-dimensional package containing thousands of solid-state ionization chamber detectors in a properly instrumented missile, coupled with an amplifier and telemetering devices, we could enable scientists on earth to determine radiation measurements immediately."

Treatment of Cancer

Dr. Friendland stated that detection of alpha particles and neutrons which has been difficult until now, is simple using the new detectors.

As an example, the potential use of the solid-state detector in the treatment of cancer was described.

"Boron, an element which tends to concentrate in malignant tissue, for a limited length of time, would be injected into a cancer patient. Hughes detectors, imbedded in the noses of hypodermic needles, would be inserted into the diseased area.

"The patient would then be exposed to a stream of neutrons," Dr. Friedland said. "When the boron reaches its heaviest concentration, neutrons striking it would create alpha particles that would flash through and destroy diseased tissue.

"The detectors would detect the alphas and determine when boron concentration reaches its peak and how long it lasts, and instantaneously transmit the information to electronic readout devices.

"With this data, technicians could plot precisely future treatment and determine the minimum effective exposure to radiation," Dr. Friedland said.

Basic Research

Dr. Friedland next turned to basic research:

"Tracking nuclear particles in experimental problems today usually involves complex instrumentation and expensive coolants, such as liquid hydrogen. The low temperatures reduce the noise levels of the apparatus which makes the equipment operable.

"But again," he said, "these coolants and their supporting equipment cost money. The Hughes detector which operates at room temperature can provide better analysis more accurately and much more cheaply."

Dr. Friedland singled out the now commonly used "bubble chamber," which he said cost more than $1 million to develop, as an example.

"Bubble chambers are a means of measuring nuclear particle direction and energy," he said. "They involve simultaneous photography from a number of different angles, resulting in difficult and time-consuming scientific analysis of thousands of pictures. The use of many detectors in conjunction with electronic data-handling equipment could result in lightning-like determination and analysis of facts in many fields of physical research."

It was stated that the detectors are already installed in various research and university laboratories about the nation; in fission experiments, alpha spectrometers, and scattered experiments involving particles of the mass of the proton and higher.

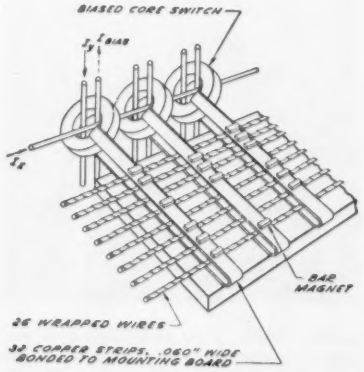
Computer Memory Based on Tiny Magnetic Devices

DEVELOPMENT of a new, accurate, and fast electronic memory has been reported by Western Electric Company and Bell Telephone Laboratories.

Hair-thin wires wrapped with magnetic metal tape in barber-pole fashion plus tiny bar magnets are the basic elements of the permanent electronic memory which is comparatively inexpensive, easy to produce, and will help speed up computer developments. The memory will supply bits of information at speeds in millionths of a second to a computer.

Twistor Permanent Magnet Memory

The permanent magnet memory is the result of a pair of technical achievements: the conception of a memory based on the inhibiting action of a permanent magnet on the magnetic characteristics of a Twistor formulated by Bell Telephone Laboratories researchers; and the development of mass production facilities for memory units by Western Electric in a period of 14 months.



SECTION of a Twistor-magnet memory frame. Three cores of the biased core switch or transformer and their word coils or solenoids are shown, with eight intersecting Twistors. The bar magnets are shown as tiny "blocks" on the word coils. (For reasons of simplicity, the plastic tapes supporting the Twistor wires and the word coils have been eliminated in this drawing, as has the plastic card carrying the bar magnets.)

Manufacture of the memory modules in quantity and at the levels of precision demanded by the tiny dimensions and close registration of some of its components required close co-operation of technical personnel in both companies. The development, design, and pilot production phases, although telescoped into a brief period, have now yielded a unit which can be efficiently manufactured by automatic techniques. Thus, program memory units for computer systems are available which combine high-speed operation and formerly unobtainable reliability.

The memory module is built up of arrays of tiny permanent bar magnets located on plastic cards which are superimposed on a Twistor-conductor grid sensing element. The bar magnets are formed by first bonding a 0.001-inch-thick sheet of Vicalloy I, a magnetic material, to a plastic card. The card is then subjected to a high-precision photoetching process to eliminate all the magnetic material except the small bars left at specifically desired locations. The tolerances required for this photoetching process are far narrower than those needed in standard photoetching work.

The sensing element for these magnets is an underlying grid of horizontal and vertical conductors. The wires running in one direction are magnetic and are called Twistors while those in the perpendicular direction are current conductors. Twistors are prepared by putting a spiral wrapping of molypermalloy magnetic tape around a copper carrier wire. This wrapping produces a spiral magnetic path around the conductor when a current is passed along the tape and the carrier wire. A number of these magnetic wires are embedded in a strip of Mylar film, each with a plain copper wire alongside it for a return current carrier. The other co-ordinate of the grid is made up of strips of copper foil 0.060 inch wide, also embedded in a Mylar film. This conductor-bearing film is folded over the Twistor strip in such a way that one complete loop is formed; each loop of copper strip provides a single turn solenoid

BASIC COMPONENTS of the magnet-Twistor memory module, recently announced by Western Electric and Bell Telephone Laboratories, are discussed by H. L. Stadler and D. G. Clemons of Bell Laboratories. A partially assembled module is in the foreground, with a completed unit behind it.

at right angles to the Twistors. For access to the memory, the open end of the solenoid (or "word coil") is connected to a biased ferrite core switch or transformer. Because of the square hysteresis loop characteristics of this core, it also provides a selection scheme for picking a particular "word coil" out of a matrix of such coils. Neither the ferrite core switch nor the Twistor-conductor grid stores information in itself; they are used only for access to the permanent magnet memory.

The Twistor-conductor grid is used to sense the presence or absence of a field from a permanent magnet. The field inhibits the action of an electrical pulse through a "word coil" on the magnetic properties of the Twistor itself. If there is no magnet at a given intersection, a corresponding pulse is generated in the Twistor and read out. If a magnet is present, its field prevents the production of the Twistor pulse; and no signal is read out. The signal from the Twistor is about 6 millivolts at an impedance level of 10 ohms and is about 1 microsecond long. The computer interprets this signal or lack of signal to indicate a specific command and acts on it to do its computation.

By inserting a new card with a different arrangement of magnets, the memory can be changed easily and reliably to a new program when conditions require. Accuracy of registration in the program cards is assured by the use of guide pins, and the entire card is held in close proximity to the Twistor grid by springs. The separation of the magnets from the sensing wires is only a few thousandths of an inch. There are no wired connections between co-ordinate wires of the access grid or between the grid and the permanent magnet memory—their interaction results from proximity alone.

The first step in the manufacture of the Twistor-conductor grid is the preparation of the magnetic tape used in wrapping the copper carrier wire to form the Twistor. Molyperhalloy wire is first drawn to a diameter of approximately 0.001 inch then roll-flattened to a tape 0.0035 inch wide by 0.0003 inch thick. A specially designed test set continuously checks the magnetic quality of the wire, allowing identification of that part of the product which could cause faulty operation of the memory.

The wrapping process required a development program of its own. A machine had to be designed which took into account the low strength of the materials involved, yet would wrap the tape about the 3-mil (40 Awg) carrier wire quickly with a high degree of uniformity. High uniformity is necessary to minimize variation in the magnetic characteristics of the final assembly. An output of 300 feet of Twistor per hour is possible with the machines now in use. With a 45 degree helix, this requires 1,140 turns of tape per foot of carrier wire or a speed of 5,700 rpm for the wrapping head.

Drawing permalloy tape to these small dimensions and then applying it in helical form were significant "firsts" in this development.

Twenty-six pairs of Twistor-return wires are then laminated between sheets of Mylar tape. These wire pairs are positioned on 0.100-inch centers across the width of the tape; the separation between a Twistor and its associated return wire is 0.020 inch. A memory module is built by interweaving the Twistor tape, the copper "word coils," and the plastic magnet cards. An array of tiny transformers is made, one connected to each "word coil" of the module. A registration mechanism insures that the magnets on any program card are aligned over the proper bit position. The unit is assembled into a compact, mechanically rigged, reliable memory package.

A special test set, which is essentially a computer in itself, was required because of the complexity of the module and the variety of conditions under which the memory module might be required to operate.

The Twistor got its name from early work by A. H. Bobeck of Bell Laboratories, who showed that a wire with a twisted magnetization could be switched by either current flowing down the wire or by current flowing down another wire perpendicular to it. If such wires were then woven into a grid with plain copper wires, the intersections could be used to store bits of information in a temporary computer memory.

Army Finds New Way To Measure Polar Ice Caps

The depth of polar ice caps has been measured by radio waves in the Arctic and Antarctic, the Department of the Army announced recently.

The new technique promises to replace laborious seismic soundings in many instances. It was developed by an Army explorer-engineer, A. H. Waite of the U.S. Army Signal Research and Development Laboratory, Ft. Monmouth, N.J.

While seen primarily as a promising new means of measuring polar ice, its findings also offer a warning to polar fliers. Pulses from their radio altimeters may penetrate the icy surface and give dangerously deceptive readings. The possibility is greater at low altitudes.

Scientists have worked for decades to make detailed measurements of the gigantic ice masses. Ice up to 2 miles in depth covers more than 5 million square miles in the Antarctic. In Greenland, 0.75 million square miles are ice-covered to a maximum of some 7,000 feet.

The established seismic method is to pick up and analyze sound waves from explosives set off on or near the ice surface. Though accurate, it is time-consuming and expensive and requires skilled seismologists.

Radio soundings can be made as fast as an operator can move across the surface in a "Weasel," a small cargo and personnel tracked carrier. Helicopters skimming a few feet above the surface could also be used as survey vehicles, it is believed.

A modified 10-watt radio altimeter originally designed for aircraft was used. Special directional antennas for transmitting and receiving signals were mounted on the Weasel to be 4 feet above the ice surface.

Depth is determined by measuring the time required for transmitted signals to pass through the ice, reflect off the hidden ground beneath, and return through the ice to the receiving antenna. This fractional time is shown on a scope similar to a television tube in presenting electrical pictures. The slower velocity of radio signals moving through polar ice is taken into account. Mr. Waite established this speed as approximately half the normal radio wave speed of 186,000 miles an hour when traveling in a vacuum.

Radio as a glacial yardstick was suggested to Mr. Waite in 1955 and 1956 while transmitting signals horizontally through Antarctic ice. These studies showed radio wave penetration allowed signals to pass through ice easily.

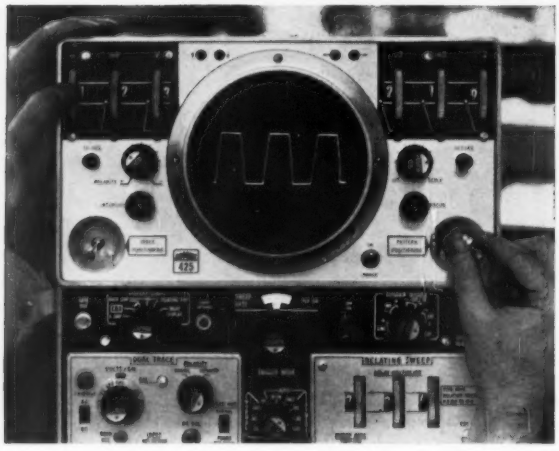
Basic Scientific Tool Now May Be Used by Unskilled Worker

The cathode-ray oscilloscope, a basic tool of the electronic era, formerly used only by engineers and trained technicians, can now be used for the first time in manufacturing and process control by unskilled production workers.

Developed by Allen B. Du Mont Laboratories, Inc., Clifton, N.J., a high-frequency, general purpose oscilloscope, containing the most significant advances in cathode-ray instrumentation since its development by Du Mont 30 years ago, was demonstrated recently.

The new instrument, designated as Du Mont model *425*, features the first direct digital reading system in an oscilloscope. It includes, among other innovations, modular construction, a series of interchangeable plug-in amplifiers, and a new cathode-ray tube. The unit is useful over a frequency range from d-c to 60 mc (down 3 db at 35 mc).

In application, the importance of the digital readout system is seen in its contribution to laboratory accuracy, production, quality control, and other manufac-



THE FIRST oscilloscope to feature digital readout, the new Du Mont *425* is "human engineered" to eliminate error in measurement, interpolation, and correction for parallax in waveform analysis. The digital readout (top left and right thumb wheels and indicators) is regarded as the most significant feature of the unit because it reduces immeasurably the time required to obtain measurement in laboratory application.

turing operations where the scope may now be used by the worker without any technical training. In the technical laboratory, as well, the unit promises to reduce the measurement and analysis time required by engineers for oscilloscope readings by approximately 40% through the use of its direct digital readout. Furthermore, it provides more accurate measurement.

It was predicted that from the production line to medical laboratories and hospitals, where its improved stability and ease of operation will be a boon to operative and diagnostic procedures, the unit will find new vital applications.

In radar range indications, for example, the readout can be made to indicate radar distance directly in yards, and in television work pinpointing wave shape characteristics through a digital readout will now be possible.

The direct measurement of response of pulse circuits as well as determination of the efficiency of scintillation crystals in the atomic energy field are other applications that are now completely feasible. Quantitative measurements in this area as well as in chemical processing should also be greatly improved.

The direct numerical portrayal of time and amplitude which appears on the front panel of the instrument is accomplished through the manipulation of two measuring dots on the face of the scope which are moved by "joy-stick" controls and thumb wheels so that they are aligned with the waveform presentation being studied. Three-place amplitude readings in volts and time readings in microseconds, milliseconds, or seconds are read directly when the dots are aligned. In addition to the inherent accuracy of the system—which virtually eliminates all possibility of human error in interpolation, parallax adjustment, and computation—repeatable readings are readily obtained through the standardization of the dot positioning. Accuracy is 2%. The repeatable measurements can be applied to peak-to-peak voltage investigations as well as studies of instantaneous voltages with respect to ground, rise and fall times, elapsed times, repetition times, or frequency, and phase angles between two identical waveforms.

Provision is made for accurate repeatable measurement of rise time through the digital readout and the use of a push button on the face of the panel, which, when activated, will move the indexing dot up 10% and the scaling dot down 10% of the total amplitude. The original settings are not affected by the momentary change.

Through two 40-pin connector plugs at the top of the chassis, the scope may be tied in directly with external data-processing equipment including punch cards and printers. For remote analog devices such as computers and recorders, an analog voltage proportional to the digital reading may be taken out of the scope directly.

The design of the *425* incorporates five basic modules built into a main frame. This physical construction enables the user to eliminate costly repairs and down-time by simply interchanging any damaged module with its exact replacement. All individual electrical and mechanical entities, the modules include the distributed amplifier, the low-voltage power supply, the high-voltage power supply, the X-chassis and sweep circuits, and the front panel which incorporates the readout generator, sync circuits, cathode-ray tube, and general framework.

All components used are standard types, and the use of precision resistors and tubes of 10,000-hour mean time to failure results in long trouble-free life. The *425* does not require any tube selection.

The design of the distributed amplifier module is representative of the new features incorporated in the unit. This module utilizes a twin-tetrode to establish wide-band characteristics and has a single cathode sleeve which eliminates cathode-lead inductance and, in turn, provides higher input impedance at higher frequencies. The feature also eliminates the need for preselection of replacement tubes. In addition, the amplifier contains a highly refined constant resistance filter section and employs a novel canted tube alignment for the prevention of capacitance coupling.

Whereas previous instruments of this nature contained no more than one plug-in, the Du Mont *425* scope provides two plug-in facilities. A wide variety of interchangeable amplifiers offers complete versatility and insurance against obsolescence. The interchangeable units for X functions include delaying sweep, dual-trace capabilities, and X-amplification. The Y plug-ins presently range from a 50-millivolt/cm, 33 mc amplifier to a 500-microvolt/cm, 3- to 5-mc unit of high stability and balanced input. Signal generators, passive delay units with resolution to 1×10^{-10} seconds, wide-band sampling scopes, and power access plug-ins will shortly become available.

The new cathode-ray tube, especially designed for incorporation with the *425* offers extreme sensitivity, high light output, fine resolution, and an acceleration potential of 12,000 volts.

"Suppressor" Prevents Transistor Breakdown

An electronic device which will prevent a common cause of failure in transistorized aircraft electronic equipment has been developed for the U. S. Army by the electronics department of Hamilton Standard, division of United Aircraft Corporation.

Termed a "suppressor," the unit will limit both positive and negative transient voltages in d-c power applied to transistorized equipment. These transients are frequently sufficient to break down a transistor and disable essential airborne equipment such as flight controls, communications, and navigational aids.

Spike transients are limited in the Hamilton Standard suppressor to a peak positive voltage of 45 volts and a peak negative voltage of —1 volt. This can be safely tolerated by the transistors.

Unit weight of the device is approximately 2 pounds and it measures only 4½ by 2½ inches.

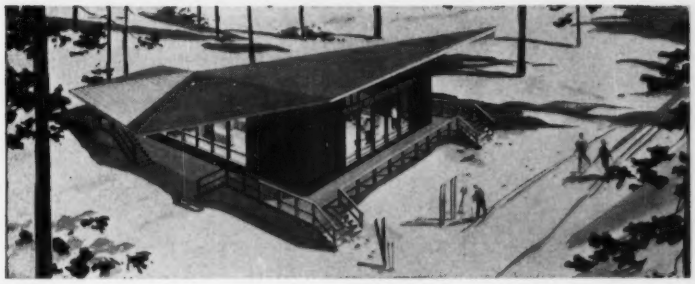
Computing System Helps Score The 1960 Olympic Winter Games

The use of electronic data processing made the scoring of events of the 1960 Olympic Winter Games the fastest in Olympic history.

To make possible up-to-the-second accounts of standings and competitions in all the colorful events, the International Business Machines Corporation (IBM) gave without charge the services of a team of skilled technicians and the use of the IBM RAMAC *305* computing system.

Months before the Winter Games officially opened at Squaw Valley, Calif., the IBM team was busy filling RAMAC's magnetic memory with the instructions necessary to calculate automatically the scores as specified by the complex rules of each of the 26 events.

As a result, the hundreds of athletes from the various participating countries knew the results of their efforts as well as their competitors' while the events were still in progress; complicated winter-events scores, involving form and style as well as speed and distance, were officially computed in a matter of seconds and minutes rather than hours; and spectators at a single vantage point could keep track of most of the action as it happened, knowing from minute to minute the exact



THE OLYMPIC Data-Processing Center (above) at Squaw Valley, Calif., was staffed with skilled personnel and equipment lent by IBM to make possible faster and more complete scoring data to press, radio, and television throughout the 1960 Winter Games. *Right:* A punched card was prepared for every Olympic competitor, containing name, number, and country represented, and to which was later added the results of his efforts in an event. Here, IBM operators prepare the cards before being entered into RAMAC for automatic computation.

standing of all competitors in all events.

An intricate network of communications, data-processing equipment, and the skilled teamwork of officials and technicians made this possible. They were linked together by 1 million feet of communication cables, running from every point within the 6,000 acres of the Winter Games' area.

From the judges on the scene, a competitor's performance was flashed to the Olympic Data Processing Center for computation and official scoring. Key to the high-speed scoring there was the RAMAC's magnetic memory, in which was stored the equivalent of a million words of Olympic scoring rules and information about the competitors.

The most immediate action of an individual competitor, as relayed from the judges on the scene, was added to a punched card on which other pertinent data had previously been punched.

The data on the card, including the most recent, was "fed" into the computer, automatically computed according to the special rules of the event, and compared with other contestants' scores. Any penalties were reported to the machine, and scoring adjusted accordingly.

Within seconds the completed results were printed out on high-speed printers, and included the competitor's name, number, country, point-total, and his place among all contestants. The final results were also automatically punched into teletypewriter tape for transmission to the judges' stand, press centers, and other points.

Electronic data processing thus made it possible to determine the winners of most Olympic events in less than 2 minutes—from remote point-of-action to final printed result, and regardless of the complexity of scoring for the event.

The electronic system was also organized to score several different events simultaneously, and as each individual competitor finishes, to update the standings automatically.

The system added further enjoyment to followers of the Olympics by having in its memory—ready for instant retrieval and printing at the touch of a button—colorful performance data on all competitors in both English and French. With this detailed information made quickly available, the vast international audience serviced by the press, television, and radio was brought closer to the Games.

And for the participants themselves, the RAMAC system even printed an official "Certificate of Competition"—a permanent memento for every competitor of his own performance during the VIII Olympic Winter Games, February 18-28, 1960.

Microwave Transmission Through Buried Waveguide

Flexible, cylindrical waveguide has been developed by International Telephone and Telegraph Corporation (ITT) to carry many hundreds of television, microwave radio, and telephone signals in dense traffic routes where it is impractical to use additional coaxial cable or radio relay links.

The new waveguide is expected ultimately to carry up to 400 television channels or equivalent telephone channels in a single conductor approximately 3 inches in diameter. Normally, the waveguide will be buried.

In conventional microwave systems, rectangular waveguide has such high inherent attenuation losses that its length is limited to a few hundred feet. However, a cylindrical waveguide, using the circular electric mode of the signal, greatly reduces attenuation losses and the system can be operated with a very great bandwidth to carry a large number of channels.

Millimetric waves (wavelengths less than 1 centimeter) enable the circular waveguide to have reasonable dimensions, an enormous available bandwidth, and sufficiently low attenuation to make it useful for many miles.

Ideally, maximum efficiency is obtained from an optically straight waveguide with a perfectly circular cross section. Such an installation is, of course, impractical. One of the solutions to the bending problem has been achieved by the Standard Telecommunication Laboratories of Standard Telephones and Cables, Ltd., a British affiliate of ITT.

The ITT solution is to form the guide with helically wound aluminum wire covered with a waterproofing and strength-

A LIVE television broadcast as it appeared on a receiver screen (above) after being picked up from a regular broadcast and sent more than half a mile (3,600 feet) through a hollow metal pipe in tests conducted by ITT. Right: The hollow metal pipe (arrow), 3 inches in diameter, is inspected by electronics engineers at Hertsfordshire County, England. The pictures are believed to be the first ever transmitted a considerable distance by such pipe, technically known as circular waveguide, or transmitted by a method developed and patented by ITT, called pulse code modulation. Ordinarily, waveguide is used to send signals less than 100 feet.

ening coating. This construction enables the microwaves to follow bends in the conductor without prohibitive losses.

Transmission in a long waveguide is subject to a signal distortion arising from echo effects and from time delays in signals carried by parasitic modes. The use of pulse code modulation greatly increases the discrimination against noise and delivers a signal that is easily regenerated.

In the pulse code modulation system, signal amplitudes are sampled at a frequency slightly more than double the top frequency component of interest. The amplitude samples are converted into a binary code. The coded signals modulate the output of a continuous-wave millimeter-wave oscillator. Preliminary experimental equipment using a 5-mc sampling frequency and capable of coding 16 different signals levels recently has been demonstrated displaying a television picture. It is believed that this equipment is the first to show pulse code modulation transmission of an actual moving television picture.

With a 3-mc video bandwidth and a usable spectrum in the waveguide of 80,000 mc, the system would possibly give a capacity, per waveguide, of 400 television channels or several hundred thousand one-way-telephone conversations.

The expected attenuation of a long distance pipe of this type is about 2 db to 3 db per mile. Pulse regenerative repeaters will be used approximately every 20 miles, a distance corresponding to a 60 db attenuation.

A demonstration by Standard Telephones and Cables, Ltd., at Frogmore Hall, Herts, England, transmitted the pulse code modulated television signal through a 3,600-foot loop of 2¾-inch waveguide. The loop consisted of a 1,800-foot length of the helical aluminum guide and a 1,800-foot length of optically straight plain aluminum tube. Two specially designed right-angle corners, at the far end, returned the signal from the helical to the plain guide.

The transmitted television picture is acceptable to ordinary viewing but is not good enough for long distance transmission. An improved version of the equipment is under development using a 10-mc sampling frequency and coding 54 levels.

Columbia To Offer Degree of Nuclear Engineer

Columbia University's School of Engineering will offer a new degree of nuclear engineering beginning with the 1960-61 academic year next September.

Donald Barr, assistant to the dean of the Faculty of Engineering, said the new degree is for professional engineers who wish to practice nuclear engineering but who do not need a doctorate.

Mr. Barr said the degree of nuclear engineer, to be called the "N.E." degree, will be "more advanced than a master of science degree but less rigorous than a doctorate." He said the degree requires 30 points of courses beyond the master of science degree, but requires 60 points of courses beyond a bachelor of science degree if the candidate did not previously receive an M.S.

The N.E. degree does not require a thesis if the student submitted a thesis for a master's degree. Comprehensive examinations are required, however.

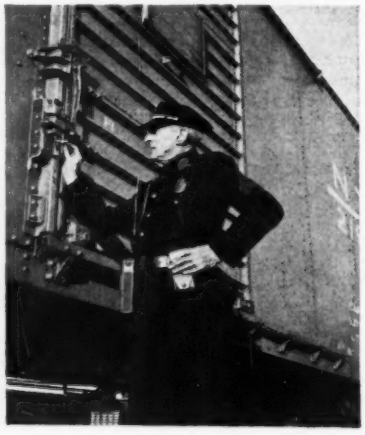
Railroad Police Wear "Handie-Talkie" Radio Sets

A radio communication system, which permits policemen to cover yard areas using lapel microphones, is being employed by the New York Central to protect the railroad's vast property complex in the New York metropolitan area, including New York City, Westchester, and New Jersey.

Key unit in the new system is a lightweight receiving-transmitting unit called a "handie-talkie." The power pack for the unit is fastened to the officer's waist and the microphone is attached to his coat lapel so that his hands are always free.

Although the officer may be on duty at a remote point, 2-way radio contact can be maintained with another "handie-talkie" patrolman, a radio-equipped cruiser car, or, at a limited distance, with the Central radio dispatch desk.

The operation is centralized at a radio dispatch desk where a lieutenant and patrolman monitor round-the-clock all major railroad police activities in the metropolitan and surrounding area. When the need for assistance arises, the bureau can immediately broadcast a message to a radio-cruiser car or a "handie-talkie" operator, directing them to the scene of the incident.



NEW YORK CENTRAL Police Sergeant B. C. Curtis has his hands free to check the protective seal on a freight car while he broadcasts a message on the new "handie-talkie" radio set attached to his uniform. The microphone is attached to his lapel. Central police have been equipped with the portable set to speed up communications while they are on the job protecting freight shipments and railroad property. Officers using the "handie-talkie" set can communicate both with police cars and with the Central's radio dispatch desk, headquarters for the railroad's short-wave system.

Engineers Hear About World's Fair Scheduled for 1964

A talk by Robert Kopple, director of the New York World's Fair–1964, was given to the Engineers' Club of New York at a luncheon on January 12, 1960.

Mr. Kopple outlined the conception and development of the idea of the 1964 Fair. The idea began in May 1959 and was developed to the point where a Presidential Commission selected New York as the United States site and further selection took place over four other cities in the International Commission Meeting in Paris.

The 1939 files, although not well organized, were all preserved in the New York library.

The City appropriated $80,000 for preliminary work. Commissioner Robert Moses has a report in preparation on the new project.

It has been decided to use the Flushing Meadow location of the previous World's Fair where there are about 1,250 acres already available with some buildings, many fine trees that were planted 20 years ago and have now grown up, and the old piling which supported the structures of the 1939 Fair.

The 1939 Fair employed 25,000 people. At that time, employment was very slow and prices were low; the Fair organization itself was able to assemble a large and mostly competent crew. It is expected that conditions in 1964 will require that most of the organization and maintenance of the Fair will have to be subcontracted.

The present temporary executive officers of the Fair are in the Empire State building, but the administration building is to be ready on the Fair grounds by Spring of 1960 so that all of the personnel engaged in the preliminary work can be concentrated, there.

The first committee to be assembled will be the committee on design which will outline the arrangements.

The theme of the Fair is "Peace Through Understanding."

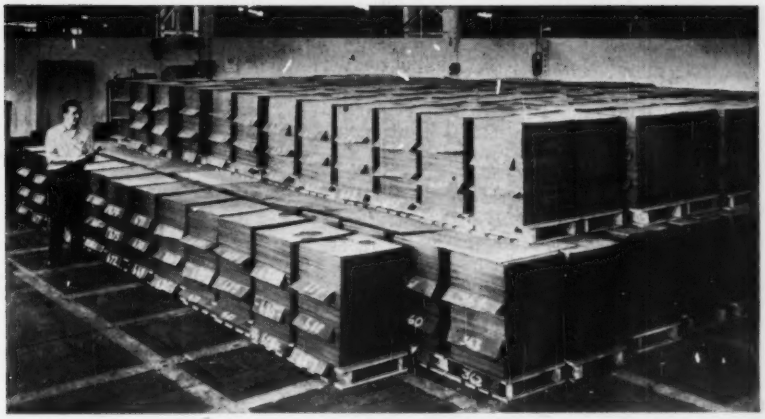
These Fairs offer an opportunity to be radical in design, to try out new ideas and the uses of new materials in new applications, etc., because the designer is not under the obligation of being economical or of making a profit.

Some 82 nations are to be invited to participate in the Fair as against 65 that were available in 1939. The United Nations is expected to have its own building and to serve as a clearing house and center for setting up the international exhibits.

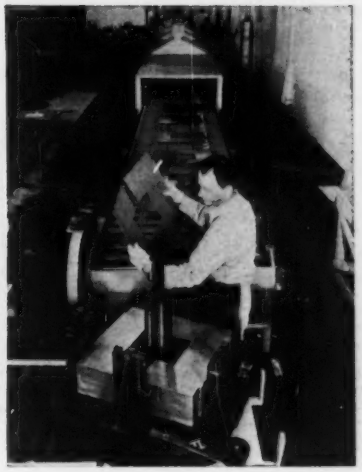
On the subject of costs and returns, it was reported that the 1939 Fair cost $155 million and only about one-third of that was returned directly to those who invested in it. However, over a billion dollars was spent in New York as a result of the Fair being located in that city.

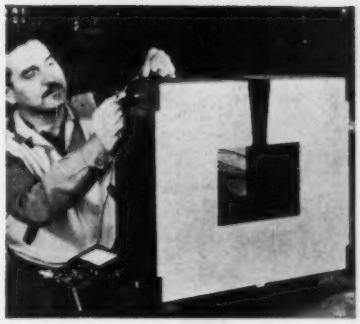
It is anticipated that the 1964 Fair will cost $500 million and will be seen by over 60 million people who are expected to spend between $5 and $6 billion in New York City.

The Fair is scheduled to open on April 30, 1964, and close on November 1, 1964.



SHUFFLED LAMINATIONS, ready for a production process that will convert the 475 tons of steel shown above into 612 magnet cores for the Cambridge Electron Accelerator. Each of the 420,000 sheets of transformer grade electrical steel is approximately 0.014 inch thick and each sheet is picked up and positioned by hand three times during the production process. Laminations are shuffled to insure that steel from different heats at the mills does not result in variations in the magnetic properties of the completed cores. *Right, above:* Precured laminations emerge from oven conveyor and are stacked on a special fixture which insures their alignment. The sheets must be stacked so that the 10.5-inch-thick cores will be in true alignment across the pole faces within 0.001 inch.





COMPLETED core *(right)* is checked with sensitive ohmmeter to be sure that all laminations are electrically insulated by the bonding adhesive. Finished cores, packed in special crates, are being shipped to Cambridge at the rate of 30 per week. The process was developed by the Eddystone Division of Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa.

"White-Glove" Method Used To Make Synchrotron Cores

White surgical gloves, an "old-style" rubber-base glue, and a do-it-yourself paint remover from a local hardware store play important parts in a unique adhesive-bonding process being used to fashion 475 tons of steel into magnet cores for an electron accelerator described as the world's biggest.

The process was developed by the Eddystone Division of Baldwin-Lima-Hamilton Corporation which is making 612 magnet cores for the 6-billion-electron-volt Cambridge Electron Accelerator, a research machine under construction at Harvard University.

Built up from 420,000 laminations, each one less than 0.015-inch thick, the magnet cores will form the heart of the accelerator's system for keeping electrons in orbit as they are accelerated around a ¼-mile track to velocities approaching the speed of light. Discharged at a target (usually liquid hydrogen), the fast-moving electrons will enable physicists to uncover new facts about the fundamental nature of matter.

The white surgical gloves are needed to handle the laminations as they go through critical points of the block-long adhesive-bonding process set up in a hospital-clean wing of one of Eddystone's sprawling metal-working shops at Eddystone, Pa. The gloves are worn because natural body oils, normally present on the hands, would destroy the perfect bond needed between adhesive and steel to insure that the cores will perform according to specifications.

A rubber-base phenolic resin, in use for many years before the development of epoxy resins, was chosen as a bonding medium because, according to P. D. Peltier, head of the Eddystone project team that developed the process, ". . . a rubber-base adhesive will hold the steel sheets together without mechanical bonds of any kind. At the same time the rubber-base adhesive creates fewer production problems on this particular job than one of the new epoxy resins."

The do-it-yourself paint remover—obtained from a local hardware store after a wide assortment of industrial chemicals had been tested and found relatively ineffective—is used to clean excess adhesive from pole faces and reference surfaces after the cores have been baked in an electric curing oven.

Before starting full-scale production, 24 prototypes were built and shipped to Cambridge for testing. When all cores met perfectly the design specifications, Cambridge authorized Eddystone to start production. This was the first sure sign Eddystone had that its bonding method—developed after 7 months of research and testing—would work.

Now, in an immaculate wing of an Eddystone shop, cores are being turned out at the rate of 30 per week on a block-long production line.

CORRECTIONS: On page 5, January 1960 issue, the caption for the upper-right-hand photograph should read "Carolina Power & Light Company's Darlington plant."

On page 11, same issue, the caption for the upper-left-hand photograph should read ". . . an accuracy of within 0.05 per cent of the indicated value."

Occupation Question—1960 Population Census

The 1960 Population Census will begin April 1. Information concerning the occupation of each person 14 years of age or older will be requested of every fourth household.

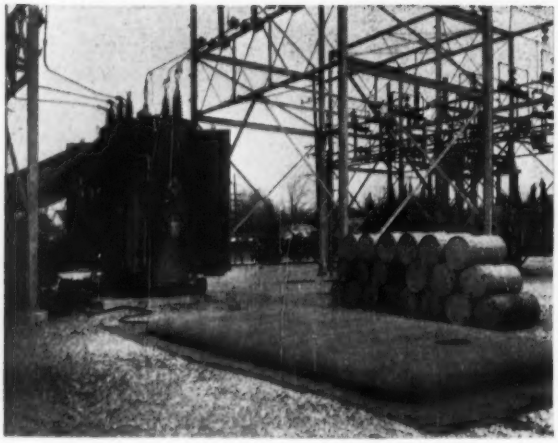
In order that the statistics on scientific and engineering manpower be developed as accurately as possible, the Census Bureau wishes to remind readers that the question on occupation should be answered completely and precisely. In most cases, the entry should consist of at least two words.

Some examples of acceptable entries are: consultant electrical engineer; design electrical engineer; electrical engineer; electrical engineer, process; estimating electrical engineer; factory engineer, electrical; field electrical engineer; inspection engineer, electrical; project electrical engineer; testing engineer, electrical.

"Pillow Tank" Aids in Substation Maintenance

A 3,000-gallon collapsible container, shaped like a large rectangular flattened pillow, has enabled the Long Island Lighting Company (LILCO) to perform maintenance on substation equipment more quickly and safely.

This synthetic rubber "pillow tank,"



"PILLOW TANK" being used to store 1,500 gallons of oil drained from a 20,000-kva transformer during field maintenance operations at a LILCO substation. On the right are some of the 30 steel drums that would have been needed prior to the utility's use of the synthetic rubber container.

recently purchased from the Goodyear Tire & Rubber Company, is being used by LILCO to aid in the repair of oil containing units such as substation transformers and circuit breakers. The oil within this type of equipment must be drained and stored before any maintenance work can begin. It was necessary, before the pillow tank, to store this oil in steel drums, interrupting the drainage as each drum became full. The reverse process of returning the oil was a similarly disjointed operation. The removal of 1,500 gallons, not extraordinary in transformer maintenance, meant the juggling around of 30 drums and took 2 hours. The same operation with the pillow tank is a continuous process requiring only 45 minutes. In an emergency situation, as well as in normal field maintenance, the substitution of this single, compact 320-pound unit for the great weight and awkwardness of up to 60 drums means a much quicker start and a faster completion of needed repairs.

In larger sizes, ranging up to 10,000 gallons, the pillow tank has been used by the U.S. Air Force for fuel "paradrops" and has been towed through the water by merchant ships for added fuel storage.

"Sea" Being Built for ASW Test Program

A man-made "sea" is under construction at Sperry Gyroscope's plant in Great Neck, N. Y., to help solve the major problem in developing detection equipment for antisubmarine warfare (ASW)—the water itself.

The main limitation on underwater detection devices is the environment in which they must be used. Sound travels through water for comparatively short distances. While radar can pick out aerial targets thousands of miles away, SONAR (Sound Navigation and Ranging), which depends on bouncing sounds off subs or detecting the sounds made by them, is effective only for a relatively few miles. SONAR, and variations on it, is the principal method of sub detection.

Testing detection devices at sea where the conditions, such as storms, ocean turbulence, rolling and pitching of the ship, etc., cannot be controlled, would take a much longer period of time to achieve the same results that can be obtained in the Sperry "sea" where conditions can be varied and controlled under a laboratory environment.

The "sea" being built by Sperry consists of a test basin about 400 feet long, 200 feet wide, and 25 feet deep. The basin, adjacent to the company's environmental test laboratory is now being dredged. It is the only facility of this type being operated by a private company.

Turbulence in the water and the presence of water temperature layers can interfere with detection equipment, and a school of fish or a whale can be mistaken for an enemy sub. One of the most important characteristics in sub detection equipment is selectivity, the ability to reject the sounds of static, turbulence, waves, and fish while clearly identifying the sound of the submarine.

A 17- by 29-foot floating barge will be used on the test basin to sink the sensing equipment under evaluation into the water. Equipment to perform precise measurements and to simulate the desired sound of subs, fish, and other disturbances will be placed at the other end of the basin.

Electric cables and a communications channel will link the barge to an adjacent test building, permitting complete remote control operation of the experiments. Approximately 25 million gallons of water will have to be diverted from the basin to holding basins north and south of the site. The test facility was previously used in the company's water conservation program.

Not only sound devices such as SONAR, but nonacoustic instruments for the location of antiship mines, torpedoes, and submarines can be tested at the new facility.

Another advantage of using the test facility will be the ability to test thoroughly equipment slated to be installed aboard subs prior to installation.

In addition to working on advanced detection equipment, the company is producing ASW torpedo fire control equipment for POLARIS submarines. This electronic brain, which can control the direction of torpedoes even after they are fired, will give POLARIS subs the capability to destroy hunter-killer subs seeking to sink them. A device for controlling such ASW torpedoes as the ASTOR, which can be installed in older subs, giving them an ASW capability, is being produced.

Teletypewriter Equipment Speeds Up Library Service

In the fully stocked Free Library located on Logan Square, Philadelphia, Pa., Kleinschmidt teletypewriters used in conjunction with belt conveyors, book lifts, and electrical signaling devices, help speed the flow of books from the stacks to the reading public and back again.

All large libraries are faced with the crucial problem of cutting to a minimum the time readers must wait for books which are stored in the stacks. In Philadelphia, the problem was especially acute because of the size of the building (60,000 square feet), the vast distances between the second floor reading rooms and the underground stacks, and the fact that the library is so well patronized (about 20% of the population of Philadelphia are registered borrowers).

The system works as follows. When a reader presents his card or order for books, the librarian in charge types out the order on the Kleinschmidt teletypewriter, which reproduces it as page copy both on the sending unit on one of the second-floor library departments and on one of two teletypewriters in the nerve center of the stack area in the basement of the building. The order is acknowledged by teletypewriter message from the page to the librarian. The page then gets the books off the stacks, places them on a conveyor belt or book lift, depending on destination, and signals the librarian by pushing a button which turns on a red light on the desk of the librarian, indicating that the order has been filled and is on its way up. A page in the second-floor library department then picks up the order and delivers it to the reader. Normal elapsed time: 8 to 12 minutes.

Library officials point to a number of advantages in using teletypewriters to transmit orders for books to the storage area. For one thing, it assures speed, clarity, and accuracy. The order is transmitted and received simultaneously in original typed form, with no possibility of being misunderstood. A telephone order, on the other hand, is subject to misunderstanding, garbling, or other errors. Telephoning also takes longer, for the page in the storage area must write the order down as it comes over the phone.

Another advantage of using teletypewriters is that if the pages are all busy getting books off the shelves, the orders are there waiting for them when they return to the nerve center of the storage area. Instead of jangling, unanswered telephones, there is a continuous flow of typed orders coming in over the Kleinschmidt teletypewriters.

Altogether, 150 to 175 orders are processed on a normal weekday via the tele-

typewriter network. On Saturdays, the average is higher—from 200 to 225. The busiest time, however, is during the Sunday library hours of 2 to 6 p.m. During this 4-hour stretch, the teletypewriters—and the pages in the storage area—are really kept "hopping" with an average of 175 orders.

Warning Buzzer Has Highway Safety Applications

A warning buzzer to notify motorists when their cars are too close to the pavement edge was demonstrated recently before the Highway Research Board in Washington, D. C.

Developed by electronics-instrumentation department, General Motors Research Laboratories, the "Electro Lane" is analogous to the "beam" by which aircraft pilots maintain course from one airport to another.

A. F. Welch, head of electronics-instrumentation, said the Electro Lane is a simple low-frequency (2 kilocycle) electromagnetic device that could be installed easily in or beside any paved road at relatively low cost. The road system could be powered either by 12-volt batteries or an a-c power line with 12-volt batteries for takeover in event of power failure. It works this way:

Low-frequency wires parallel either side of the pavement or in case of 2-lane, 2-way roads, one wire could be beside the pavement on the right and the other laid in the center or divider strip. The wires in effect create an electric fence.

Cars are equipped with ferrite core pickup coils hanging from either side of the front bumpers. Whenever a car veers or drifts toward the right pavement edge or the center strip to the left, one or the other of the pickup coils come within 2 to 3 feet of the buried wire loop.

The coils pick up electrical signals from the wire. These are boosted by a transistorized amplifier until they activate a buzzer on the car's instrument panel. Mr. Welch said it would be possible to use a 2-tone buzzer, one tone signifying the car is heading left off the pavement, the other indicating the car is running too close to the right side of the pavement.

As a safety device, Mr. Welch said, the Electro Lane would have several safety applications:

1. Obviously, it might serve to alert an inattentive or sleeping driver that his car was heading off the road.

2. It would be especially helpful to motorists groping through darkness, mist, or fog. Also, it would help a motorist on a snow-covered road.

3. It might help prevent head-on or side-swipe collisions on 2-way, 2-lane highways by warning motorists when they are drifting over the centerline into the path of oncoming vehicles.

The system might first be used as a hang-on unit which a motorist could put on his car on entering a turnpike check-in station and take off when he left the turnpike, Mr. Welch suggested. Or it could be built into the vehicle as optional or standard equipment.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

PROGRESS IN NUCLEAR PHYSICS, Volume Seven. Edited by O. R. Frisch. Pergamon Press, Inc., 122 E. 55th St., New York 22, N.Y., 1959. 326 pages, 6¼ by 10 inches, bound. This is the latest in a series of annual volumes presenting authoritative papers summarizing the broad range of recent advances in nuclear physics. The bubble chamber, the resonant interaction of gamma rays with nuclei, and an optical model for nuclear scattering are recently explored areas discussed. In addition, the articles deal with the measurement of helicity, spallation, and with weak interactions. Extensive references are given at the end of each paper.

RADIO STATIONS: INSTALLATION, DESIGN AND PRACTICE. By G. A. Chappel. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1959. 248 pages, 5¾ by 8¾ inches, bound. $7.50. A highly practical approach to the subject is presented for the planning of station design engineer and the field installation technician. Based on up-to-date practice, each aspect is discussed, ranging from general planning, site selection, and ground systems to detailed station layouts, equipment rooms, message distribution systems, and wiring systems. Although largely devoted to small station design, much of the material included also is applicable to large stations.

SYMPOSIUM ON BASIC RESEARCH. Edited by Dael Wolfle. American Association for the Advancement of Science, 1515 Massachusetts Ave., Washington 5, D.C., 1959. 308 pages, 6¼ by 9¼ inches, bound. $3. Various reviews of the concepts and implications of basic research in general are followed by discussions of the relationship of basic research to the liberal arts college, the state university, and the private university. This is then followed by studies of its relationship to Government and industrial laboratories as well as private research institutes. Concluding sections cover the available means of securing financial assistance.

TECHNIQUES OF PLANT MAINTENANCE AND ENGINEERING, Volume X. Published by Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N.Y., 1959. 266 pages, 8 by 11 inches, bound. $10. The papers presented at the 1959 National Plant Maintenance and Engineering Show provide a permanent record of advances in the field to date, and cover a broad range of subjects from the over-all organization of the plant engineering and maintenance functions to such newer developments as numerically controlled machine tools and maintenance work in nuclear plants. The papers included cover safety, labor relations, training, scheduling, and many aspects of maintenance. The book concludes with round table discussions on individual types of plants based on practical experience.

TRANSIENTE VORGANGE IN WECHSELSTROMMASCHINEN. By K. P. Kovács and I. Rácz. Akadémiai Kiadó, Budapest, Hungary, 1959. 2 volumes, 7 by 9¾ inches, bound. No price given. A German translation from Hungarian, dealing with transient phenomena in a-c machines. The book treats the transient phenomena in both synchronous and asynchronous machines, with emphasis on the physical characteristics. Moreover, an attempt is made to solve accurately the individual problems with the aid of modern mathematical and theoretical means (operational calculus, symmetrical components). Volume I covers basic concepts and synchronous machines; Volume II covers asynchronous machines. There is a bibliography of 99 references.

ALLGEMEINE WECHSELSTROMLEHRE, Volume II. By H. F. Schwenkhagen. Springer-Verlag, Berlin, West Germany, 1959. 441 pages, 7 by 10 inches, bound. 39 DM. This second volume of a textbook on general a-c theory deals with four-poles, line theory and practice, wave phenomena, and electromagnetic fields in space. As in volume I, the examples presented were taken both from power and communication engineering practice.

AMERICAN POWER CONFERENCE: PROCEEDINGS, 1959. Published by the Illinois Institute of Technology, Technology Center, Chicago 16, Ill. 776 pages, 6½ by 9½ inches, bound. $8. These papers give practical information of broad over-all interest to those concerned with the generation, transmission, or utilization of power. The book is divided into sections dealing with topics of general interest; nuclear energy; electrical, mechanical, and water technology. The papers in each of these areas cover technical, economic, and industrial aspects. They are written by people connected with universities and societies, industries and Government, laboratories and utilities.

AUTOMATING THE MANUFACTURING PROCESS. By G. F. Hawley. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 1959. 147 pages, 6¼ by 9¼ inches, bound. $4.95. The author presents in practical terms some of the mechanical problems involved in inventing and designing machinery for specific operations, such as assembly of components, packaging individual products, bottle capping, and feeding. He sketches the background of economic feasibility for a project, describes the roles of the inventor, design engineer, and production planner in the processes of devising, modelling, building, and running the automatic machine.

ENGINEERING ECONOMICS FOR PROFESSIONAL ENGINEERS' EXAMINATIONS. By Max Kurtz. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N.Y., 1959. 261 pages, 5½ by 8½ inches, bound. $6.50 Various aspects of engineering economics are reviewed in this text which discusses the media of investment, the time value of money, sinking funds and annuities, valuation of bonds, depreciation and depletion, annual costs, analysis of variable costs, and the legal and business phases of the construction industry. A practical feature is the inclusion of many exercises and problems which illustrate typical questions asked in professional engineers' examinations throughout the country.

NATIONAL SYMPOSIUM ON VACUUM TECHNOLOGY, TRANSACTIONS, 1958. Published by Pergamon Press, 122 E. 55th St., New York 22, N.Y., for The American Vacuum Society. 282 pages, 8½ by 11 inches, bound. $15. The 54 papers in this volume review the year's development in vacuum technology, and the information contained in them is of value to all concerned with vacuum science and engineering. The fields covered are the fundamental basis of techniques, vacuum systems and instrumentation, ultra-high vacuum, and vacuum-deposited magnetic and thin films. Industrial applications, applied science and research, and education in the field are also discussed.

Library Services

ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

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TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

ENGINEERING COLLEGE RESEARCH REVIEW 1959. Published every 2 years by the Engineering College Research Council (ECRC) of the American Society for Engineering Education, this summary of the research being done by the Council's member colleges is presented to assist colleges, students, and especially Government, industrial, and foundation sponsors of research by identifying the institutions conducting research in the areas of interest to each group. Over 10,000 research projects are now underway in 118 leading colleges in the United States, and expenditures on these activities during the current year will total over $112 million. The survey gives complete titles for all projects underway in schools which hold ECRC membership; in addition, numbers of research personnel at each institution are listed, and research policies are summarized. There is a complete index of research project subjects to help locate activities in similar fields at different institutions. In some cases, the time spent during the year on each project is indicated in terms of full-time equivalents. The review has been edited by Dr. Renato Contini and P. T. Bryant. Copies of the review are available from the Secretary of the American Society for Engineering Education, University of Illinois, Urbana, Ill., at $2 each.

COMPILATION OF STANDARDS ON ELECTRICAL INSULATING MATERIALS D-9. This edition contains 108 standards of which 46 are new, revised, or have their status changed since the previous edition in 1957. Among the topics covered are: insulating shellac and varnish; effects of radiation; plates, sheets, tubes, rods, and molded materials; ceramic products; solid filling, treating, encapsulating, and embedding compounds; flexible sheet, tape, and tubing; insulating papers; mica products; magnet wire insulation; electrical tests; serving units and conditioning methods; plastics for electrical insulation; rubber tape and electrical protective equipment; textile materials for electrical insulation; and general test methods. Copies of this book may be obtained from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. at $8.75 each.

C. R. C. STANDARD MATHEMATICAL TABLES. This revised 12th edition, published to assist scientists and engineers as well as technical educators and students, in practical research, has additional new information on the following: curves and surfaces; table of integrals; random units; algebraic series; basic concepts for algebra of sets, integral domains, groups, fields, rings; Bessel functions, vectors, mathematical symbols. It may be obtained from the Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, Ohio at $3 per copy. The same publisher has made available the 41st edition of **HANDBOOK OF CHEMISTRY AND PHYSICS** which contains 3,400 pages and 5 indexed sections: mathematical tables, properties and physical constants, general chemical tables, heat and hygrometry, quantities and units. Price $12 each.

BIBLIOGRAPHY ON FILING, CLASSIFICATION, AND INDEXING SYSTEMS FOR ENGINEERING OFFICES AND LIBRARIES. This is a selected list of references prepared for engineers and librarians concerned with organizing files. The references are to books, pamphlets, and magazine articles on filing, classification and indexing, lists of subject headings, and hand-sorted punched-card systems suitable for organizing small collections of engineering books, notes, correspondence, abstracts, reprints, drawings, maps, manufacturers' catalogs, etc. There is a subject index as well as an introduction in which selection and use of the systems are discussed. With 155 annotated references, 33 pages, multilithed, it is available from the Engineering Societies Library, 29 W. 39th St., New York 18, N.Y. Price $2.

RULES FOR THE SHORT-CIRCUIT TESTING OF CIRCUIT-BREAKERS AND AUTOMATIC SWITCHES IN COMBINATION WITH ELECTRIC FUSES AND FUSE-LINKS. Since ASTA (Association of Short-Circuit Testing Authorities) Publication No. 9, "Rules for the Short-Circuit Testing of Circuit-Breakers in Combination with Back-Up Fuses," was published in 1950, there has been an increase in the variety of switching equipments which operate in series with fuses or fuse-links. In these equipments, the circuit-breaker or switch operates up to a prescribed limit of over current, above which the fuse or fuse-link takes over the full breaking capacity of the equipment. In view of this increase and coupled with the experience gained in the short-circuit testing of this type equipment, ASTA No. 9 has been revised and has now been published as ASTA No. 22. This document also takes into consideration high-voltage automatic fuse switches. This publication is available from the Association of Short-Circuit Testing Authorities, 36 Kingsway, London WC 2. Price 10s.

STANDARD SYMBOLS FOR SIGNALLING SYSTEMS. Standard symbols for signalling systems, together with a plastic template and explanatory guide for the application of such symbols to architectural and other drawings, have been announced by the Industrial Electronics and Communications Equipment Division of the National Electrical Manufacturers Association (NEMA). An explanatory card, which accompanies each template, provides easy-to-follow instructions for using the basic system symbols and keying them numerically to various components of the signalling system. For template and guide write to C. A. Parris, Signalling Apparatus Section, National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y. Price 35¢.

NEMA STANDARDS PUBLICATIONS. The following new and revised publications are available from the National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y.: ADI-1959 Adsorption Equipment, 30¢; GG 1-1959 Manufactured Graphite Electrodes, 30¢; DC 7-1959 Refrigeration Controls, 30¢; EI 1-1959 American Standard Requirements for Electrical Indicating Instruments (Panel, Switchboard, and Portable Instruments) $2.50; LG 3.1959 Installation of Vertical Hydaulic-Turbine-Driven Generators, $2; MW 2.1959 Polyurethane-Coated Magnet Wire, 30¢; MW 15-1959 Vinyl-Acetal-Coated Magnet Wire, 30¢; MW 17-1959 Vinyl-Acetal Nylon Coated Magnet Wire, 30¢; MW 19-1959 Vinyl-Acetal Self-Bonding Magnet Wire, 30¢; SG 5-1959 Power Switchgear Assemblies, $4; WD 2-1959 Wiring Devices, 20¢; XR 2-1959 X-Ray Equipment, 30¢.

RURAL ELECTRIFICATION IN THE UNITED STATES. This 48-page booklet describes rural electrification's progress and how years of research, development, and promotional efforts by the nation's investor-owned electric power companies contributed to it. The information is based on the records of electric companies, electrical manufacturers, and farm groups as well as on technical and trade journals and information compiled by agencies of the Federal Government. Single copies of the booklet are available, gratis, from the Edison Electric Institute, 750 Third Ave., New York 17, N.Y. Additional copies at 90¢ each.

OTS PUBLICATIONS. Office of Technical Services (OTS) has released the following publications:

Four Navy engineering manuals: including *Power Generation and Distribution, Chapter 2—Mobile Emergency Plants* PB 161056, May 1954, 70 pages, price $1.75; *Power Generation and Distribution, Chapter 3—Fuels* PB 161058, June 1959, 140 pages, $2.75; *Power Generation and Distribution, Chapter 4—Power Plant Water Conditioning* PB 161055, December, 1953, 112 pages, $2.50; *Power Generation and Distribution, Chapter 9—Distribution of Steam, High-Temperature Water, and Compressed Air* PB 161057, June 1954, 33 pages, $1.

Two volumes of *Thermoelectricity Abstracts*, PB 151657, May 1959, 112 pages, $2.50; and PB 151810, August 1959, 81 pages, $2.50, containing references to the literature on research, development, and application of thermoelectricity accumulated by the library of the U. S. Naval Research Laboratory.

Reports to the Air Force—*Research on Barium Titanite and Other Ferroelectric Materials for Use as Information Storage Media* PB 151835, September 1958, 238 pages, $3.50; and *Research on Automatic Computation Techniques and Components* PB 151834, December 1958, 176 pages, $3.

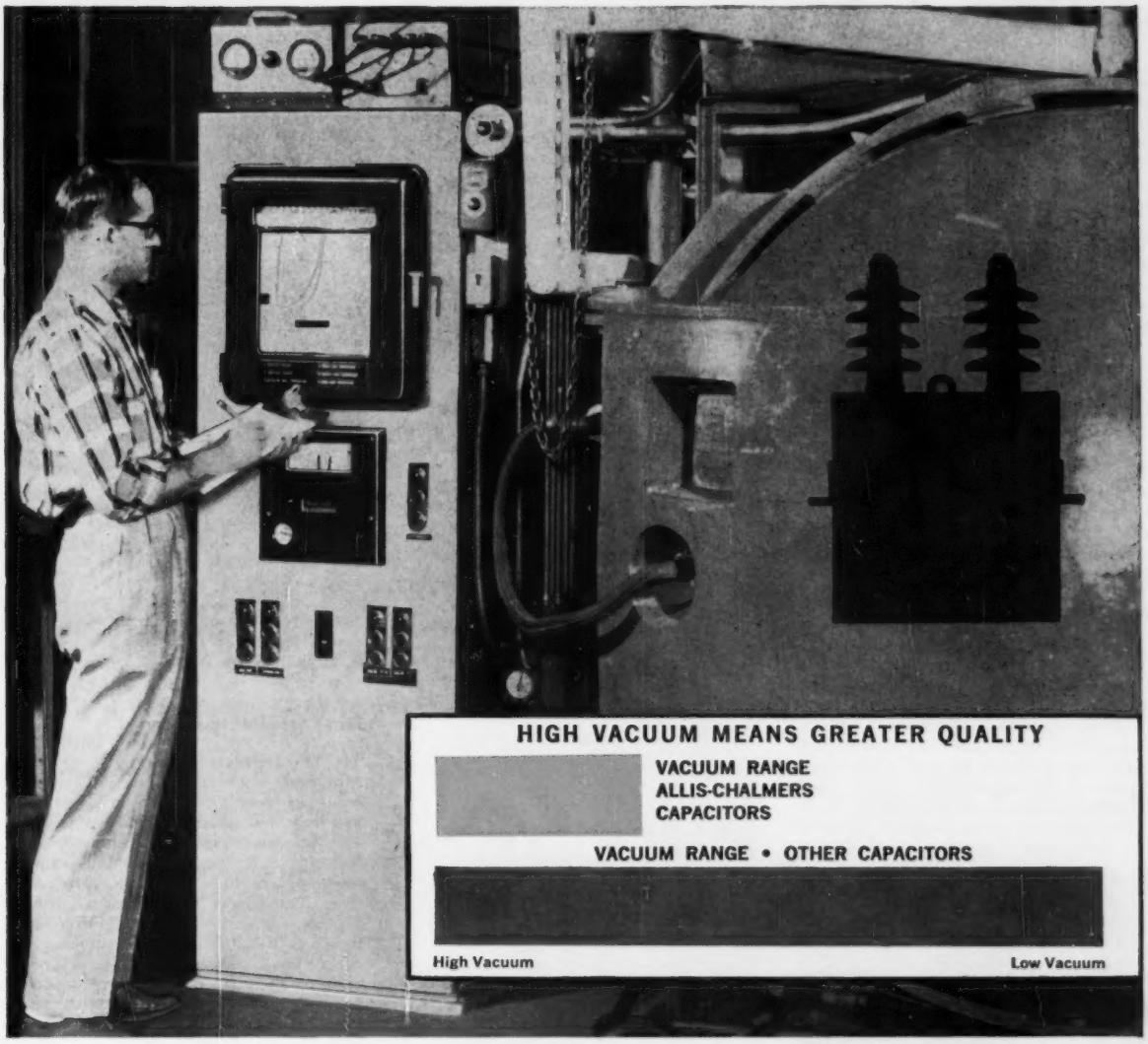
Metal-Ceramic Receiving Tubes for Automatic Production PB 151919, April 1959, 67 pages, $1.75, in which development of five electron receiving tubes capable of automatic production at the initial rate of 900 tubes per hour is described; *Electron Tube Bulb Temperature Ratings* PB 151830, January 1959, 76 pages, $2; *Development Z-5219 100-Watt CW S-Band TWT* PB 151958, June 1959, 44 pages, $1.25.

All these reports may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

OTS TRANSLATIONS OF SOVIET TECHNICAL LITERATURE. Eighteen Russian technical articles and books translated by U. S. Government agencies have been made available to the public: 59-21176 *Index of Abbreviated and Full Titles of Scientific and Technical Periodical Literature*, which is said to be the most complete Soviet reference publication on periodic literature, and which lists all Soviet and foreign periodical and nonperiodical publications processed in abstract journals of the Institute for Scientific Information, USSR Academy of Sciences, price $4; 59-11936 *A Review of Soviet Celestial-Mechanics Literature*, containing a bibliography of 580 references on celestial mechanics, $4; 59-11876 *Quantum Starship*, discussion of a starship utilizing the energy of atoms transformed into radiowave quanta, 50¢; 59-11879 *Man in Flight*, an illustrated pilot's guide to principles of aviation medicine; 59-11877 *Soviet Artificial Earth Satellite*, a general review of the launching and flight of the Soviet's first Sputnik, 50¢; 59-11991 *The Second Soviet Man-Made Earth Satellite*, a popular review of the launching and flight of Sputnik II, 75¢; 59-11988 *Rockets and Artificial Earth Satellites in Studies of the Upper Atmosphere*, which discusses Soviet, United States, and British use of rockets and satellites for upper-atmosphere studies during the International Geophysical year, 75¢; *Aircraft Aerodynamics*, three volumes: 59-11993-1, $5, 59-11993-2, $5, 59-11993-3, $3.50; 59-11995 *Homing as a Problem of Technical Cybernetics*, which applies cybernetics to control of guided missiles, 50¢; 59-11982 *Some Problems of Ionosphere Physics: Fluctuation of Electron Densities and Scattering of Radio Waves*, $1.25; 59-11998 *Polametric Study of the Nebulae IC 405 and IC 410 and the Problem of the Nature of their Cometlike Inclusions*, 50¢; 59-11996 *The Theory of the 2-Gyroscope Vertical*, 50¢; 59-11986 *On the Theory of a Gyro-Horizon Compass*, 75¢; 59-11985 *Radio Relay Systems*, 75¢; 59-11997 *Investigation of the Noise of Lead Sulfide Photoresistors*, 75¢; 59-11990 *The Problem on Automatic Frequency Control of Aircraft Parallely Connected A-C Generators*, 50¢; 59-11981 *Production, Transformation, and Distribution of Electric Power in Aircraft*, which deals with control of a-c aircraft generator voltage, a-c generators working in parallel, voltage converters and types of current, and basic information on transmission and distribution systems for electric power, $2.75. All of the foregoing publications may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

OPTICS AND SPECTROSCOPY. The Optical Society of America announces its translation of the Russian Journal *Optika i Spektroscopiya*. This leading scientific journal of the USSR Academy of Sciences publishes the work of Russian scientists in all branches of optics and spectroscopy, including x-ray, ultraviolet, visible, infrared and microwave, thin layer optics, filters, detectors, diffraction gratings, electroluminescence, thermal radiation backgrounds, infrared polarizers, and their many other applications in science and industry. The journal is free to all members and subscribers of The Optical Society of America. For nonmember subscriptions the ociety offers both the Soviet *Optics and Spectroscopy* and *The Journal of the Optical Society of America* for $28 per year. The nonmember subscriptions are to be sent to the American Institute of Physics, 335 E. 45th St., New York 17, N. Y.

ALLIS-CHALMERS



Extra years of capacitor life

through "extra-low" drying and degasification

Why take the trouble to extract air and moisture with high vacuums? This is to guarantee that you get the greatest return from your Allis-Chalmers capacitor dollar!

Better vacuum processing — a carefully controlled combination of heat and extremely high vacuum — means better penetration of the *Chlorextol* insulating liquid into the packs. Insulating paper losses and heating are reduced, electrical strength is gained. Thorough degassing increases voltage level at which corona starts. It all adds up to a big, built-in margin of safety for severe overvoltages and high ambient temperature . . . for *extra* years of capacitor life.

For more capacitor facts, call, wire or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin. A-1220

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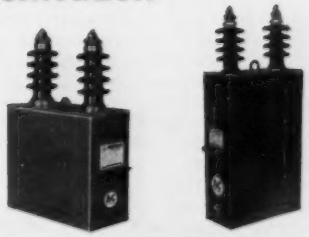


Complete capacitor equipment is available for immediate shipment—25 and 50-kvar units—2400 through 7960 volts. Includes racks, voltage and current controls, other accessories.

New and Improved Products . . .

Mercury Lamp Transformer . . .

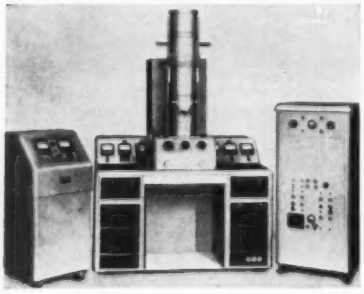
A line of constant-wattage mercury-lamp transformers has been introduced for low-temperature indoor service. The units are designed for single-lamp and two-lamp operation of 400-watt *H1*, *H25*, and *H33* lamps. Six different input voltages are available ranging from 115 to 575. Improved constant-wattage circuitry and the use of special laminations assure low lamp-current crest factor. **Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.**

Precision Jerkmeter . . .

The first highly accurate instrument to measure jerk, the rate of acceleration, operates as a subminiature servo-system of the force-balance type which is responsive to sudden movement along its sensitive axis. Accurate to 0.1%, the new instrument will provide an instantaneous output proportional to the rate of change of g's for predicting impending disaster conditions. **Donner Scientific Co., Concord, Calif.**

Electron Beam Welder . . .

A controlled high-density stream of electrons is used to change matter physically and chemically with this newly developed industrial device. Capable of making stainless steel welds of 0.060-inch thickness at the rate of 7 feet per minute and butt welds of 3/8-inch stock at 1 inch every 3 seconds, the apparatus can also precision-weld exotic metals. An intensive high-velocity electron beam operating within a



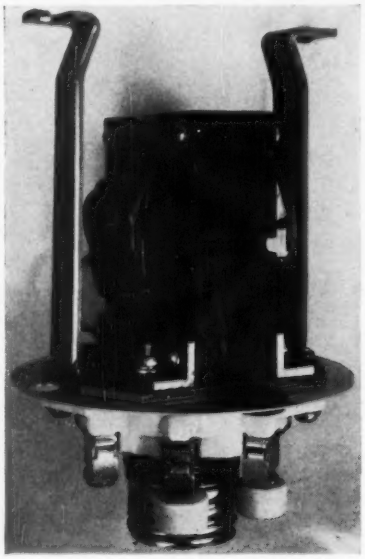
vacuum is concentrated on a workpiece zone of from 0.01 to 0.1 mm diameter. The beam's energy is then absorbed by a very thin surface layer of the material causing it to melt and vaporize. Adaptable for mass production methods, the device can also drill very fine holes and intricate slot configurations. **Hamilton Electrona Inc., 40 Wall St., New York 5, N.Y.**

Switching Transistor . . .

Said to be the fastest switching transistor yet produced, this component can perform switching functions in as little as 1.5 billionth of a second. Employing silicon as its semiconductor material, the *2N1468* is an n-p-n device with an average turn-on-time of 4 millimicroseconds while switching 40 watts peak power. The most important applications will be in computers, sampling oscilloscopes, and klystron pulsing. **Raytheon Co., Semiconductor Div., 215 First Ave., Needham Heights, Mass.**

Mercury Conversion Kit . . .

This conversion unit will convert EEI-NEMA (Edison Electric Institute-National Electrical Manufacturers Association) street lighting heads from incandescent service to mercury vapor lighting. The new unit is available for 100-, 175-, 250-, and 400-watt lamps operating on line voltages of 240 volts and consists of a unitized package which includes a lamp socket,



Courtesy Sylvania

reflector plate, choke-reactor, and anodized mounting bracket. Conversion kits are furnished with six terminal sockets for use with photo cells. Watt losses range from six for the 100-watt unit to 18 for the 400-watt unit. **Sylvania Electric Products Inc., Transformer Department, Ipswich, Mass.**

Tunnel Diodes . . .

Hand-made sample quantities of 1,000-mc tunnel diodes are now available in limited quantities to designers for experimental purposes. Features of the new component include a minimum peak-to-valley current ratio of 5 to 1, a typical peak point current rating of 1 milliampere which is held to ±10%, and a typical negative conductance of 0.065 mho. **General Electric Co., Semiconductor Products Department, Syracuse, N.Y.**

Swimming Pool Alarm . . .

Here is a swimming pool alarm that is so sensitive that the splashing of a hand in water can be detected and the resulting signal passed along to a remote alarm. The system includes a sensing element encased in a protection box for mounting on the pool wall below water level. When an object falls into an unattended pool, the sensing element detects

the sound vibration and relays the signal electrically to the alarm panel. After that the instrument washes its hands of any further responsibility. **Minneapolis-Honeywell Regulator Co., 2954 Fourth Ave., S. Minneapolis 8, Minn.**

New Insulating Material . . .

Thermal evaluation of *HT50*, a new insulating material, indicates higher overloads are possible in oil-filled transformers with no sacrifice of insulation life. The material specifically gives the same life expectancy at 30 C higher operating temperatures than standard transformer insulation papers and boards at 105 C. Comparable with standard insulating media in oil absorption, formability, and other physical properties, the material remains inert in both standard and inhibited transformer oils. **Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N.Y.**

High Fidelity Hearing Aid . . .

By extending coverage in both the low and high frequencies this instrument is capable of covering approximately four octaves. Unvoiced consonants such as "th," "f," "sh," and "h," which are most important for understanding speech, are faithfully amplified. Furthermore, this device eliminates nearly all background noises that have often been a source of much annoyance to the hard of hearing. Weighing only two ounces complete with mercury battery, the Extended Range hearing aid has a 5-transistor circuit incorporating an interstage transformer with push-pull output. **Zenith Radio Corp. 6001 W. Dickens Ave., Chicago 39, Ill.**

(*Continued on page 22A*)

THE MARK OF SORGEL

DRY-TYPE TRANSFORMERS • SPECIAL TRANSFORMERS

SORGEL ELECTRIC CO.

QUIET QUALITY

MILWAUKEE, WISCONSIN

INDOOR UNIT SUBSTATIONS • D. C. SATURABLE REACTORS

your guarantee of the preferred

DRY-TYPE TRANSFORMERS

Look for this gold seal on dry-type transformers. It is the true mark of creative engineering and manufacturing craftsmanship. It represents the choice of a Consulting Engineer who specified the best; a Plant Engineer who wanted to be assured of dependability, rugged construction, high efficiency, a full-rated load operating continuously at a safe temperature; a Wholesaler who recommended for performance first; a Contractor who insisted on guaranteed delivery, installation ease, versatility of application, plus a competitive price; and a satisfied customer who is enjoying the great operating economies found only in Sorgel's expertly designed, carefully constructed, sound-rated, dry-type transformers. Complete engineering data and design services are available from your experienced, local Sorgel Sales Engineer, or from Sorgel's sales headquarters in Milwaukee.

Complete Line for Every Purpose up to 10,000 Kva, up to 15,000 Volts, Including Special Transformers and Saturable Reactors

SORGEL ELECTRIC COMPANY

839 W. NATIONAL AVENUE • MILWAUKEE 4, WISCONSIN

Sales engineers in principal cities. Consult the classified section of your telephone directory or communicate with our factory.

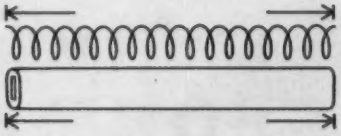
SEE US MARCH 21-24 AT THE I R E SHOW/BOOTH 1619-1621

BOURNS TRIMPOT® WITH BUILT-IN TEMPERATURE STABILITY

Stable settings under extreme temperature conditions is an outstanding feature of the Trimpot® potentiometer. This thermal stability is built-in through all phases of design and production—

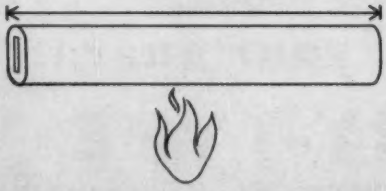
MATCHED COEFFICIENTS OF THERMAL EXPANSION

Resistance wire and mandrels have matched coefficients of thermal expansion to reduce the "strain gage effect." Linear expansion rates for the mandrel and wire match so closely that the temperature coefficient value for the entire wirewound element approximates that of the wire itself.



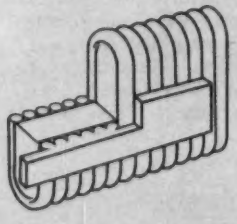
THERMALLY STABLE CERAMIC MANDRELS

Bourns takes advantage of high thermal stability of ceramic materials for element mandrels. Today, all Bourns Trimpot potentiometers provide the improved performance and reliability afforded by ceramic materials.



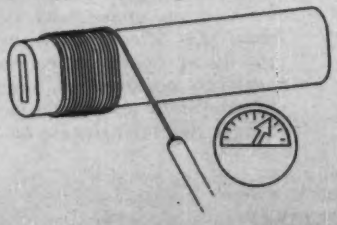
EXCLUSIVE SILVERWELD® TERMINATION

Silverweld is an actual metal-to-metal fusion of element wire and external terminal. In doing away with mechanical or soft-solder joints, Bourns eliminates potential hot spots thus extending the potentiometer's temperature range. The fusion of the Silverweld terminal to many turns of wire on the resistance element avoids the problem of single wire termination. Silverweld is virtually indestructible under thermal stresses.



EXCLUSIVE TENSION CONTROL EQUIPMENT

Bourns has developed specialized winding equipment that provides constant and precise control of wire tension during winding operations. "Necking" of the wire or resistance-altering stresses never occur. Instead the wire remains uniform—well able to withstand temperature variations with no appreciable change in resistance.



Specify Trimpot — the original leadscrew-actuated potentiometer with reliability on which you can depend. 20 basic models — 4 terminal types — 3 mounting styles.

BOURNS

BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PLANTS: RIVERSIDE, CALIF. AND AMES, IOWA

Write for new Trimpot summary brochure and list of stocking distributors.

Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

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1960 NUCLEAR CONGRESS

APRIL 4-7...COLISEUM NEW YORK CITY

Technical programs directed to engineering level, including forty-seven sessions on all phases of the peaceful use of atomic energy... plus an atomic exposition that will feature the products and services of one hundred and thirty-five major companies in the nuclear industry.

PLAN NOW TO ATTEND!

Registration at the Coliseum starts April 4. Meanwhile, get the facts. For your advance copy of the full program, mail this convenient coupon ▶

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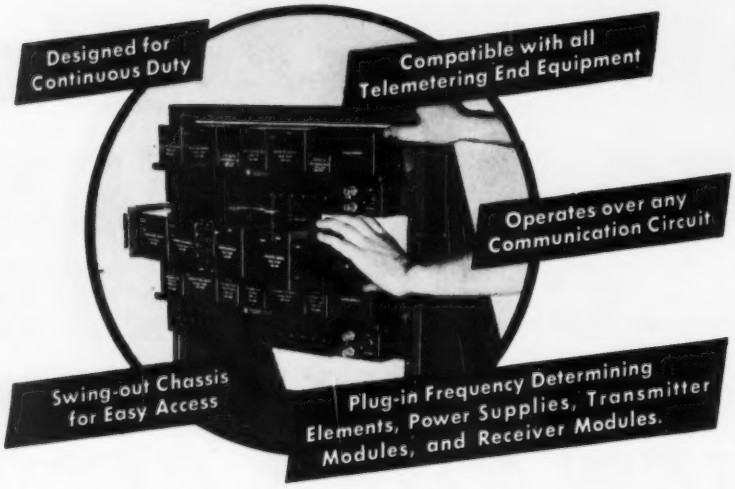
A7

REMOTE INSTRUMENTATION & CONTROL

Comtel® Transistorized Modular Terminal Units for TELEMETERING and CONTROL APPLICATIONS


Designed for Continuous Duty
Compatible with all Telemetering End Equipment
Operates over any Communication Circuit
Swing-out Chassis for Easy Access
Plug-in Frequency Determining Elements, Power Supplies, Transmitter Modules, and Receiver Modules.

The Model 1220 and 1220A Carrier Terminals are completely transistorized and may be operated from station batteries from 12 to 130 DC. Plug-in power supply is available for 115-volt AC operation. All components, including amplifiers, frequency determining components, and power supplies are contained in plug-in modules, and may be readily interchanged. As many as 22 high-speed channels are available between 300 to 3000 cps.

MODEL 1220

The Model 1220 Terminals are normally used in telegraph applications and provide all necessary carrier and loop jack fields, as well as loop current controls. Two transmitters, two receivers, or a transmitter receiver are available on a single 5¼" x 19" chassis. Operates from station battery or 117-volt AC line.

MODEL 1220A

The Model 1220A Terminals are normally used in telemetering and control applications. The individual modules are mounted on a swing-out chassis and are readily accessible. Four transmitters, four receivers, or two transmitter receivers are available on a single 3½" x 19" chassis. Operates from station battery or 117-volt AC line.

RFL REPRESENTATIVES:

ILL., MINN., IOWA, IND., WISC.
W. L. Cunningham, Elmhurst, Ill.
TEXAS, ARK., LA., OKLA.
Datatrol Co., Dallas, Texas
ALA., TENN., VA., N.C., S.C., GA.
Dickerson Eng., Jacksonville, Fla.
CALIFORNIA
Luscombe Engr., Pasadena, Calif
ORE., WASH.
J. E. Edstrom, Portland, Ore.
CANADA
Microwave Sys., Scarborough, Ont.
FOREIGN
Telesco International, New York

SEND FOR TECH. DATA — For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

New & Improved Products

(*Continued from page 18A*))

Load Monitor . . .

A load indicator designed for new or existing distribution transformers permits mounting and connection outside the transformer tank. Basically a signal light demand-type meter modified to follow the effect of ambient temperature on the transformer, the load indicator will bypass momentary peaks caused by faults or short overloads. It will also show effective demand on the transformer and indicate economic load limits beyond which a larger kva transformer should be used. **Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.**

Phase Sequence Indicator . . .

The Detekta-Faze enables the operator to predetermine the direction of rotation for any given motor without starting the equipment. The instrument contains no switches, moving parts, or batteries. Only one light is used for phase detection, and that light is either on or off depending upon the direction of rotation. The device can be used on 2-phase 3-wire systems and 3-phase 3- and 4-wire systems within an operating range of 200 to 500 volts, 60 cycles. **Glo-Lite Instrument Co., 428 Peshine Ave., Newark 12, N.J.**

Atmospheric-Particle Monitor . . .

This particle-counting instrument has been designed for continuous monitoring where ultraclean work areas are essential. A strip chart provides a permanent record of aerosols present in an over-all range from 0.3 microns to any desired upper limit. This record is differentiated into 15 subranges and recorded in sequence at intervals which can be predetermined in length. Stability problems are eliminated because the unit is continuously selfcalibrated. Counting rate is 1,000 particles per minute with a 1% coincidence loss at the standard flow rate of 100 cubic centimeters per minute. **Royco Instruments Inc., 365 San Antonio Rd., Mountain View, Calif.**

Oscilloscope Accessory . . .

Designed for coupling to an oscilloscope, this instrument has an input of 115 volts, 60 cps, with an output of 0 to 300 volts d-c. The unit was developed to observe the regulation, ripple, transient response, and other characteristics of d-c power supplies by removing the d-c component and utilizing the scope to its maximum capabilities. Since the usual method of stacking batteries in various combinations results in great variation due to the instability of battery output, the Scop-O-Trol has proved to be a reliable means of maintaining a dependable d-c voltage. **Acme Electric Corp., Cuba, N.Y.**

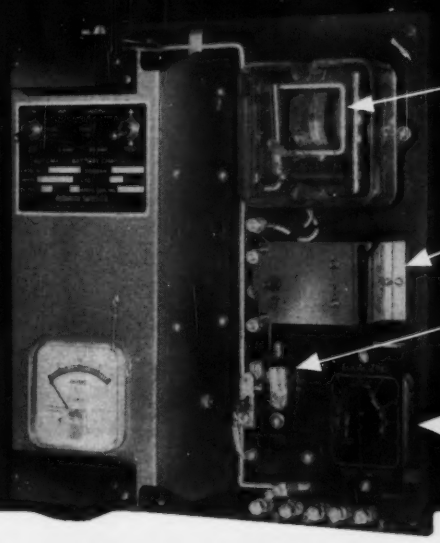
(*Continued on page 24A*)

ONE OF A SERIES: ASCO Complete Emergency Control Systems Put Standby Power in Action—FAST

Industrial Type Construction Throughout

Unit Chassis Type Charger

- Choice of 2 or 3 input voltages provided by tapped transformer
- Charging current indicated by 0-20 amp. ammeter
- Charger components protected by input and output fuses
- On-Off input toggle switch
- Momentary test toggle switch



Temperature compensated Battery Voltage Sensing Relay with dust proof cover

Field-proven, long-life A-C Motor Driven Timer

Industrial type Battery Charging Contactor with silver-gold low-resistance contacts

Selective Time Equalizer Switch provides equalization of cell charge

NEW ASCO® BATTERY CHARGER KEEPS STANDBY POWER PLANT BATTERIES FULLY CHARGED...AUTOMATICALLY

New ASCO Battery Chargers automatically keep engine starting batteries fully charged; no more weak batteries to prevent starting in an emergency. Maintenance time is minimized; the operator merely maintains the proper water level.

In Operation: while engine is stopped the battery is checked automatically once each hour. Full rate charge is applied (if required) until battery is in fully charged condition; at that time, the charger disconnects automatically. Plus Features – charger is automatically disconnected during cranking period; starts recharge immediately after!

New automatic battery charger also protects against overcharging, assures longer battery life. Electrical Characteristics: Input to 600 V. A-C, output: 6-12-24-32 V. D-C; charging rate, 6.0 amperes.

For complete information write for Bulletin 237.

Now you can select an ASCO Battery Charger to meet any of your requirements. Other battery chargers in the comprehensive ASCO line:

Non-automatic ASCO Battery Chargers: available with input voltages to 600 V. A-C; output: 6-12-24-32-36 V. D-C. Specifically designed for heavy-duty industrial use, they feature selenium rectifiers and continuous adjustment charging rate from 0.05 to 2.0 amps.

For complete information write for Bulletin 203.

ASCO Trickle Rate Chargers feature continuous adjustment range of 50 to 200 milliamperes; input 120 volts A-C; output 6, 12, 24, and 32 volts D-C.

For complete information write for Bulletin 236.

All ASCO Battery Chargers are designed to industrial control standards.

Dependable control by ASCO...

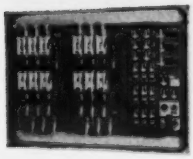
ASCO Electromagnetic Control

Automatic Switch Co. 50-K HANOVER RD., FLORHAM PARK, N. J., FRONTIER 7-4600

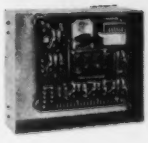
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO

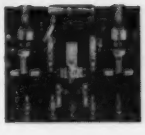
ASCO CONTROL SYSTEM COMPONENTS:



Automatic Transfer Switches, *for all classes of load to 750 volts AC-DC, transfer connected load to standby power when failure or substantial reduction of normal power occurs. Return load automatically when full power is restored—in sizes from 10 to 2000 amps. Write for Catalog 57-S1.*



Automatic Engine Starting Controls *provide fully automatic starting and stopping of diesel or gas engine driven generating sets. Write for Catalog 57-S6.*



Load Demand Controls *automatically initiate starting of engine when load is applied; stop it when load is removed. Write for Catalog 57-S6.*

Solenoid Valves *for air starting applications; for controlling the flow of cooling water; fuel oil and other liquids and gases. Write for Catalog 202.*

Solenoids *for fuel control devices, operating shutters for engine cooling, and other electric plant applications. Write for Catalog 57-S5.*

BIDDLE *Instrument News*

BIDDLE DIELECTRIC TEST EQUIPMENT

. . . for measuring direct current at voltages up to 100 kv when applied to the insulation of generators, transformers, bushings, cables, etc.

More and more engineers are leaning to d-c testing with voltages equal to or somewhat greater than equivalent peak alternating voltages. Their experience and increased knowledge and appreciation of the advantages of testing with direct voltage have accelerated the need for test equipment to meet field requirements.

IMPORTANT FEATURES

- Well-designed provisions for utmost safety
- Simple operation and reliable performance
- Excellent output voltage regulation
- Compact, mobile design
- Facilities for voltage and leakage current measurements

IMPORTANT APPLICATIONS

. . . *in development* . . . for testing the d-c dielectric strength of insulating materials and the adequacy of the electric design of insulation in any type of electrical equipment.

. . . *in production* . . . for non-destructively detecting defects in the insulation of electrical equipment due to design, material, and workmanship.

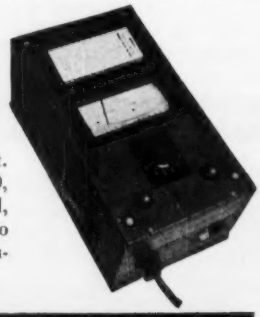
Write for BULLETIN 22-EE.

BIDDLE CORONA TEST EQUIPMENT

. . . for use in non-destructive or breakdown dielectric tests on electrical insulating materials, individual insulation structures and insulation of electrical equipment like cables, transformers, switchgear rotating machinery, capacitors, bushing and communication apparatus . . . for measuring corona starting and extinction voltage, apparent corona charge, relative corona current.

Write for BULLETIN 66-EE.

SIX-VOLTAGE MEGGER®
INSULATION TESTER



Rectifier-operated from any 115 v, 60 cps Circuit. Single Range, 10,000 megohms at 500, 750, 1000, 1500, 2000, 2500 volts d-c. Completely self-contained, one-man operated Megger Instrument designed to meet the growing needs for multi-voltage insulation tests. **Write for BULLETIN 21-20-EE.**

JAMES G. BIDDLE CO.

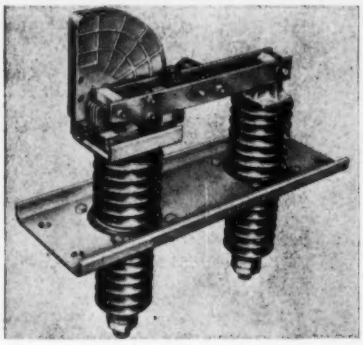
Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

New & Improved Products

(Continued from page 22A)

Interrupter Switch . . .

A modified *HPL-C* interrupter switch for high-fault closing requirements incorporates many new design features such as spring-loaded selfaligning silver-plated stationary contact fingers, silver-tungsten tipped copper blades, a special blade



guide, and an extra-heavy, formed steel base. Ratings are 600 amperes continuous and 40,000 amperes momentary with test reports showing operation on 40,000 rms amperes asymmetrical at 14.5 kv. **I-T-E Circuit Breaker Co., Greensburg, Pa.**

Extra-Sensitive Electrometer . . .

Currents as small as 1 by 10^{-17} amperes, charges to 6 by 10^{-16} coulombs, voltages as low as 20 microvolts, resistance as high as 10^{15} ohms may be detected with this sensitive instrument. Applications include air ionization studies, measurements of ion currents in mass spectrometry, radioactive measurements, and Hall effect studies. Models are available for measuring any combination of currents and voltages from grounded or ungrounded sources. **Applied Physics Corp., 2724 S. Peck Rd., Monrovia, Calif.**

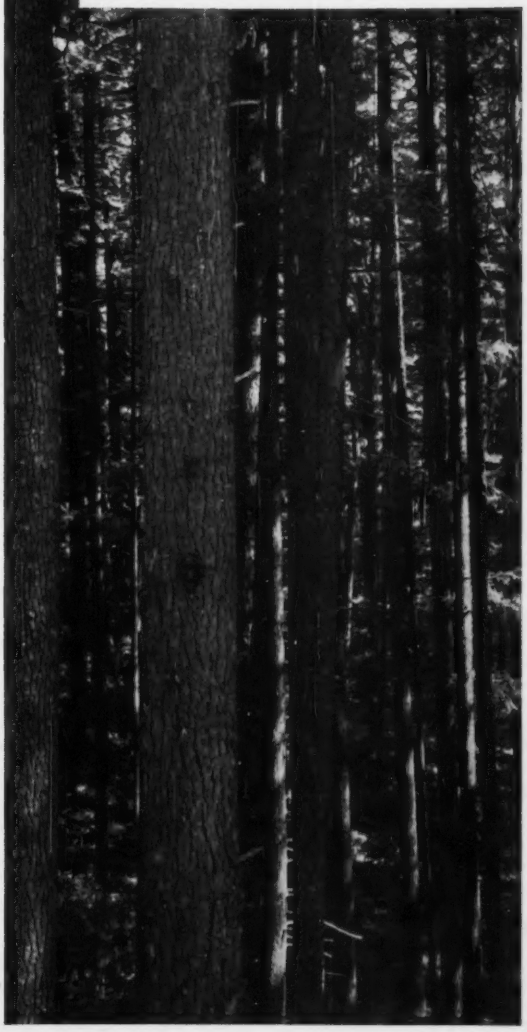
Multiconductor Cable Tester . . .

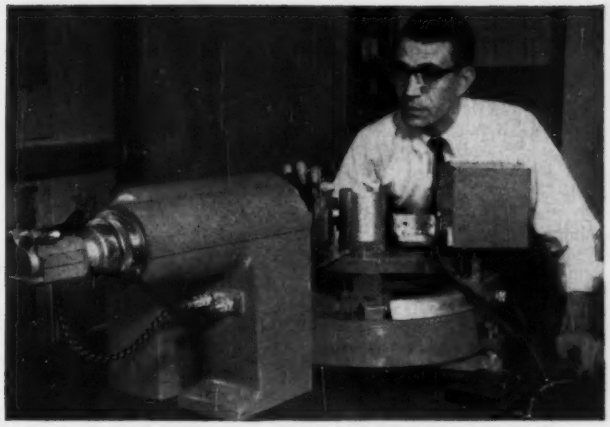
Here is a bench-top tester that will check out a 96-conductor cable for both hi-pot and continuity with a minimum amount of time and effort. Made in two separable halves, the device can be used for the testing of in-place cables when both ends of the cable are accessible. The control unit contains a numbered dial with a window to allow rapid and easy selection of any one of the conductors in the cable under test. Three hi-pot test voltages of 500, 1,000, and 1,500 volts d-c are available with minimum insulation resistance settings of 1, 2, 3, 4, and 5 megohms. The automatic readout unit contains a 96-light indicator panel to give instantaneous indication of continuity. **Leemath Inc., Oak Drive, Syosset, N.Y.**

(Continued on page 30A)

HE X-RAYS WOOD...

to help make telephone poles last longer





Chemist Jack Wright developed the use of this X-ray fluorescence machine for testing the concentration of preservatives in wood. Here he bombards a boring from a test telephone pole with X-rays.

This Bell Labs chemist is using a fast, new technique for measuring the concentration of fungus-killing preservative in telephone poles.

A boring from a test pole is bombarded with X-rays. The preservative—pentachlorophenol—converts some of the incoming X-rays to new ones of different and characteristic wave length. These new rays are isolated and sent into a radiation counter which registers their intensity. The intensity in turn reveals the concentration of preservative.

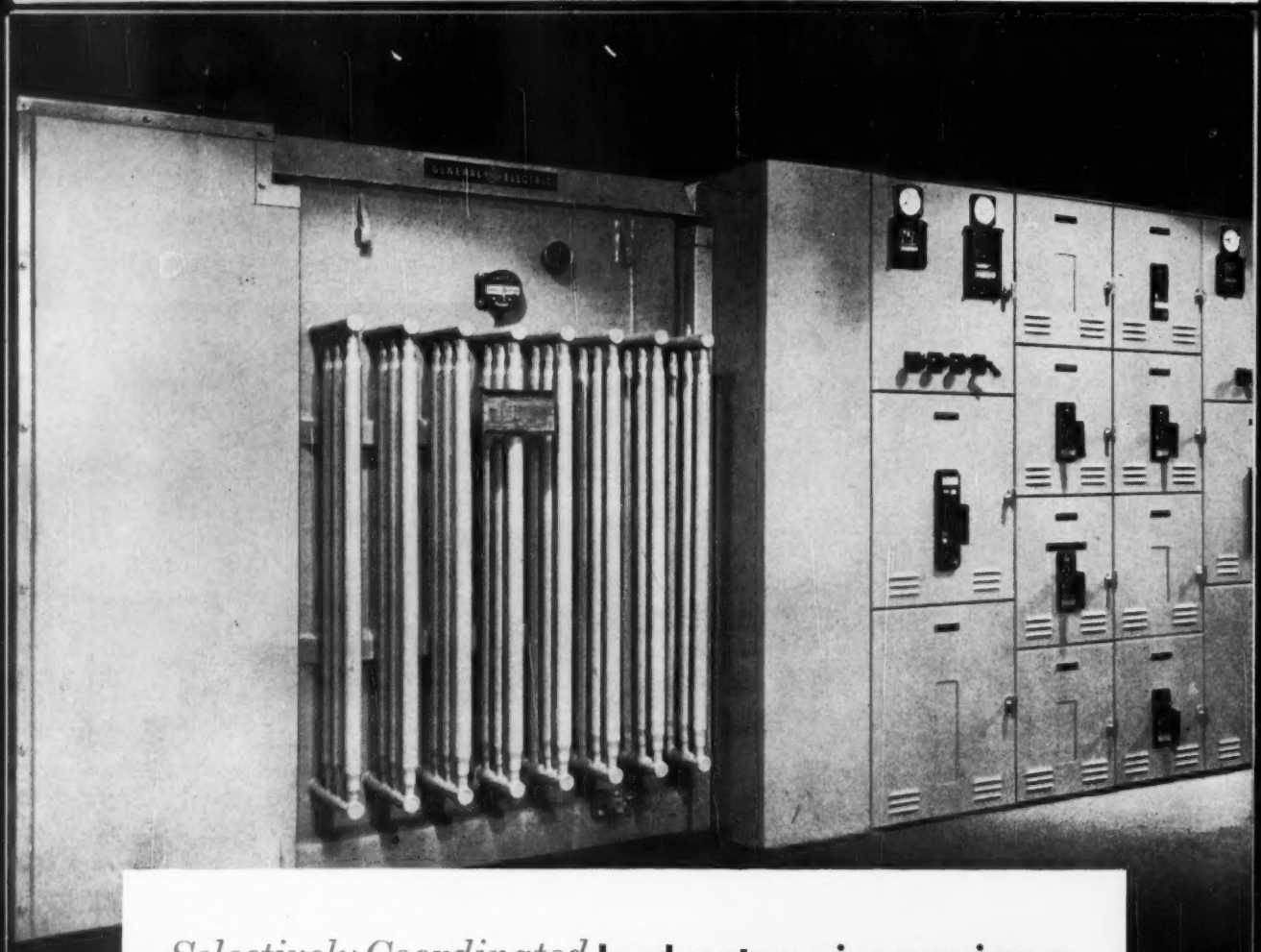
Bell Laboratories chemists must test thousands of wood specimens annually in their research to make telephone poles last longer. Seeking a faster test, they explored the possibility of X-ray fluorescence—a technique developed originally for metallurgy. For the first time, this technique was applied to wood. Result: A wood specimen check in just two minutes—at least 15 times faster than before possible with the conventional microchemical analysis.

Bell Labs scientists must remain alert to *all* ways of improving telephone service. They must create radically new technology or improve what already exists. Here, they devised a way to speed research in one of telephony's oldest and most important arts—that of wood preservation.

Nature still grows the best telephone poles. There are over 21 million wooden poles in the Bell System. They require no painting, scraping or cleaning; can be nailed, drilled, cut, sawed and climbed like no other material. Scientific wood preservation cuts telephone costs, conserves valuable timber acres.

BELL TELEPHONE LABORATORIES

World Center of Communications Research and Development



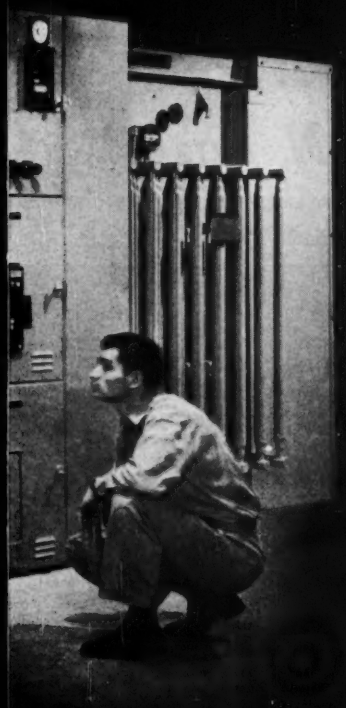
Selectively Coordinated **load centers give maximum service continuity . . . and now cost you less**

1. SAVE UP TO $600 PER BREAKER because General Electric has eliminated the price premium for selective trips when supplied with G-E switchgear equipments.

2. SAVE UP TO $630 PER BREAKER by using manually operated, stored-energy breakers in place of electrical units formerly required.

Total savings vary from $465 to $930 per breaker, depending on size.

How much can you save? Ask your General Electric sales engineer.



General Electric *Selectively Coordinated* Load Center Unit Substations now are . . .

Yours at Lower Cost

YOU NOW PAY LESS

You can purchase G-E *Selectively Coordinated* load center unit substations at new low prices. General Electric has eliminated the price premium normally charged for this inherently higher-cost, more highly-engineered product. This means that you can now get superior service for the same price as the more common, but less "intelligent," fully-rated load center unit substation. Further savings can be realized by the use of manually operated stored-energy breakers.

SELECTIVELY COORDINATED LOAD CENTERS MINIMIZE DOWNTIME

In the *Selectively Coordinated* load center, the tripping times of the main and feeder breakers are coordinated so that during short-circuit conditions, power is removed only from the faulted feeder. Power continues to flow to the unfaulted feeders—thus preventing costly, unnecessary downtime. (See diagram below.)

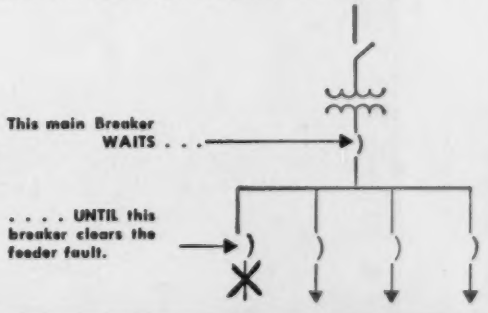
SIMPLY SPECIFY SELECTIVE COORDINATION

Order the *Selectively Coordinated* load center. Upon delivery, you will receive time-coordination curves which show you the factory-preset characteristics of each breaker, how they combine to assure you of the best possible service continuity.

For more detailed information, contact your nearest G-E Apparatus Sales Office or write to General Electric Co., Schenectady 5, N. Y. for bulletin GEA-3592. 531-01

HOW Selective Coordination PREVENTS UNNECESSARY DOWNTIME

WITH G-E SELECTIVELY COORDINATED load center unit substations, feeder breakers are adjusted to clear any magnitude of feeder fault. The selective main breaker preserves power continuity to unfaulted feeders.

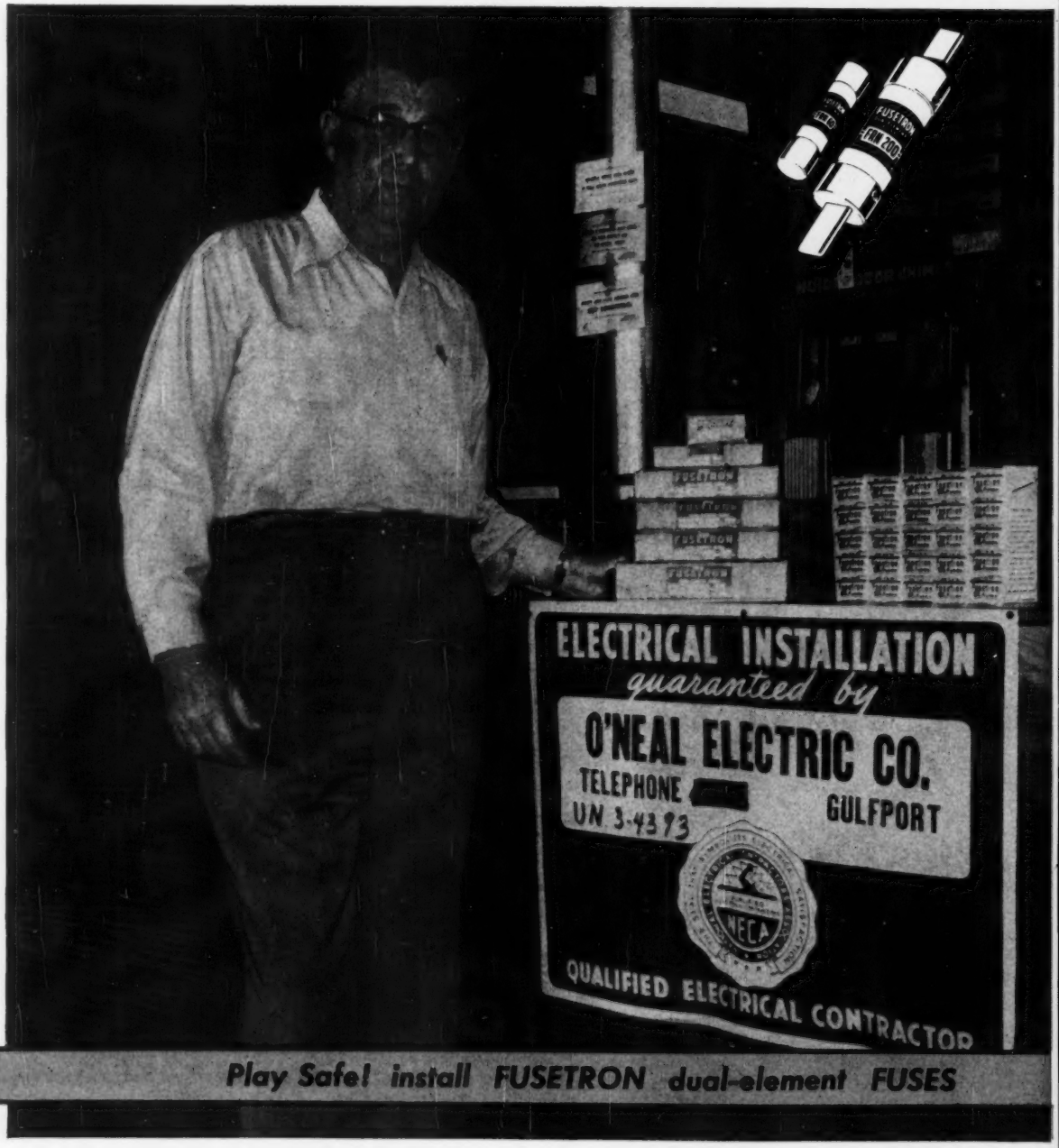


Progress Is Our Most Important Product

GENERAL ELECTRIC

"We helped a customer stop frequent outages and get safe motor protection . . . by recommending FUSETRON Fuses"

OSCAR O'NEAL SR., PRES.
O'NEAL ELECTRIC CO., GULFPORT, MISS.



Play Safe! install FUSETRON dual-element FUSES

Mr. O'Neal continues . . .

"Sometime ago, the Gulfport Ice Co., called us in to do their electrical maintenance work. At the time, they were having a great deal of difficulty with motor starting currents causing ordinary fuses to blow. They were using 100, 200 and 400 amp. ordinary fuses to protect the motors.

"These frequent outages disrupted the company's normal operation and created a costly and annoying situation. Just to replace the 400 amp., 250 volt ordinary fuses was costing them about $40 a month.

"My first recommendation to them was to change to Fusetron dual-element fuses in the proper size for safe motor protection. They did.

"The installation of Fusetron fuses was the 'key' to the problem. In the past five years I do not recall one 400 amp. Fusetron fuse having blown — and outages on the 100 and 200 amp. circuits have been very infrequent."

YOU TOO, CAN GUARD AGAINST UNNECESSARY OUTAGES OR MOTOR BURNOUTS THAT CAUSE MEN AND MACHINERY TO STAND IDLE SIMPLY BY INSTALLING FUSETRON DUAL-ELEMENT FUSES THROUGHOUT THE ENTIRE ELECTRICAL SYSTEM.

In addition to saving you money by protecting against needless outages and motor burnouts

FUSETRON Fuses offer High Interrupting Capacity and Life-Time Dependability Essential to Modern Protection.

High Interrupting Capacity: With electrical network capacities steadily increasing, — a *modern* protective device must be capable of interrupting the heavy fault currents now available and to be adequately safe to allow for anticipated growth in service demands.

FUSETRON fuses give you this protection. They have an exceptionally high interrupting rating of 100,000 amperes rms symmetrical.

Life-Time Dependability: The increase in available fault currents has emphasized the need for dependability in modern protective devices, otherwise, serious fire and personal injury can result should the device fail to operate when an emergency arises.

FUSETRON fuses provide safe and accurate protection through the years as their operation depends on a simple thermal law. Unlike mechanically operated devices, Fusetron fuses have no hinges, pivots, latches or contacts to stick or get out of order.

Once properly installed, Fusetron fuses require no maintenance, — no periodic inspection and accompanying down-time.

If you are considering a new installation or the modernization of an electrical system — you can be sure of modern, safe, maintenance-free protection in 10 or 20 years by installing Fusetron dual-element fuses now.

For more information on FUSETRON dual-element fuses . . . Write for bulletin FIS.

BUSSMANN MFG. DIVISION
McGraw-Edison Co.
St. Louis 7, Mo.

389

throughout entire Electrical System!

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS — McGRAW EDISON

Wiley BOOKS

1. ECONOMIC CONTROL OF INTERCONNECTED SYSTEMS
By LEON K. KIRCHMAYER, *General Electric Co.* Covers both theory and applications, with emphasis on developing mathematical and computer skills to supplement practical knowledge of the engineer. *1959. 207 pages, $12.50*

2. FUNDAMENTALS OF ELECTRONICS
By NORMAN LURCH, *State University of New York.* Covers the whole vast field on an intermediate level to equip the reader with a working introduction to any area, including computer systems. *1960. 631 pages. $8.25*

3. NATURE AND PROPERTIES OF ENGINEERING MATERIALS
By Z. D. JASTRZEBSKI, *Lafayette College.* Much more basic than the usual treatment, this stresses materials from the engineering viewpoint, with realistic and practical applications. *1959. 571 pages. $11.00*

4. ELECTRONIC CIRCUITS, SIGNALS, AND SYSTEMS
By SAMUEL J. MASON *and* HENRY J. ZIMMERMANN, *both of M.I.T.* A two-part treatment, concerned first with the application of algebraic methods in circuit and system analysis, then with the application of function-theory methods. *1960. 616 pages. $12.50*

5. MASERS: Molecular Amplifiers
By J. R. SINGER, *University of California.* The first on quantum mechanical amplifiers, with applications to radar, other forms. Summarizes years of research on induced emission amplifiers. *1959. 147 pages. $6.50*

6. INDUSTRIAL ELECTRONICS AND CONTROL
SECOND EDITION, *By* R. G. KLOEFFLER, *Kansas State University.* Spans the whole field, giving a complete survey of electronic theory. Initial approach is through solid state theory rather than theory of tubes. Material on magnetic amplifiers, computer principles, etc. *1960. 540 pages. $10.00*

7. BASIC DATA OF PLASMA PHYSICS
By SANBORN C. BROWN, *M. I. T.* Presents necessary data for work on gas discharges, plasma physics, plasma in controlled thermonuclear devices, and upper atmospheric research. A Technology Press Book, M. I. T. *1959. 336 pages. $6.50*

8. DIRECT CONVERSION OF HEAT TO ELECTRICITY
By JOSEPH KAYE *and* JOHN A. WELSH, *both of M.I.T.* Includes thermodynamics of irreversible processes, extending it to the fields of thermoelectricity, thermionic emission, and direct conversion of heat to electricity. Gives reports on the thermoelectron engine and solid-state thermoelectric generators. *1960. Approx. 384 pages. Prob. $8.75*

9. SELECTED SEMICONDUCTOR CIRCUITS HANDBOOK
Edited by SEYMOUR SCHWARTZ, *Transistor Applications, Inc.* Makes available a wide selection of reliable circuitry and a comprehensive design philosophy to aid in the original design of circuits for electronic equipment and systems. Stresses "building block" circuitry. *1960. Ready in April*

10. HYDROMAGNETIC CHANNEL FLOWS
By LAWSON P. HARRIS, *GE Research Laboratory.* Analyses for three flows of viscous, incompressible, electrically conducting fluids in high-aspect ratio rectangular channels subjected to transverse magnetic fields. A Technology Press Research Monograph, M. I. T. *1960. 96 pages. $2.75*

11. PROGRESS IN DIELECTRICS
Edited by J. B. BIRKS, *Manchester University, and* J. H. SCHULMAN, *U. S. Naval Research Laboratory.* Covering the entire range of the newer dielectric materials, this annual international series will consist of about 8 critical surveys in each volume. *Vol. I: 1960. 312 pages. $11.00. Vol. II: In Press.*

ALSO . . . 12. SCIENTIFIC RUSSIAN, *By* G. E. CONDOYANNIS, *$3.50* . . . 13. NOMOGRAPHY, 2nd Edn., *by* A. S. LEVENS. *$8.50* . . . 14. SEMICONDUCTORS, Abstracts, Vol. 5, *1957 Issue, By Battelle Memorial Institute.* In Press . . . 15. REGRESSION ANALYSIS, *By* E. J. WILLIAMS. *$7.50*

. . . . . .

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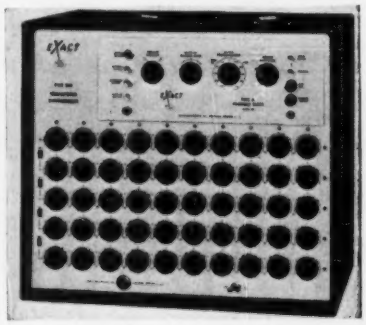
New & Improved Products

(Continued from page 24A)

Waveform Synthesizer . . .

Type *200* waveform synthesizer permits the operator to create a stable output waveform of almost any shape imaginable by separately controlling the characteristics of small segments of the total waveform with different plug-in units. The amplitude and slope of each of the



50 increments may be independently varied without interaction to create the desired waveform. Future plug-ins presently being developed will extend the flexibility of the instrument to meet the most complex demands. **Exact Electronics, Inc., P.O. Box 552, Portland 7, Oreg.**

Mine Car Control . . .

This semiautomatic control permits safer and speedier transportation of miners to their job sites. The device consists of a control panel, a remote pistol grip master switch, and a dynamic brake push-button for slowdown action on slopes. A safety feature is the control's forward-off-reverse master switch which is designed to return to the "off" position if the operator removes his hand from the grip. Now currently in use in man cars powered by 7½- and 15-hp, 250-volt d-c motors, the device will automatically control acceleration at speeds from four to five times faster than the conventional mine locomotive. **Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.**

Solenoid Lock . . .

A solenoid locking mechanism can now be furnished with the ESCO Type *JR* multipole rotary switch where it is important that circuit-control settings be changed only by authorized personnel or in a prescribed sequence. Mechanisms can be provided to lock every position of the rotary switch or certain positions can be locked and the rest left free for local control. Release can be effected by energizing the solenoid or by de-energizing the solenoid where fail-safe protection is required. The 8-position switch can be furnished in 5-, 10-, 15-, 20-, or 25-section assemblies and with a wide variety of contact arrangements. **Electro Switch Corp., King Ave., Weymouth, Boston 88, Mass.**

With Metal-Clad Switchgear...

Federal Pacific's new Protected Work-Aisle

provides safe and comfortable conditions in any kind of weather!

Note extensive work area in Federal Pacific's new Protected Work-Aisle at Pennsylvania Power & Light Company's Walnut Sub-Station, Harrisburg, Pennsylvania.

You can shield both your maintenance crews and your metal-clad switchgear from the assaults of bad weather with Federal Pacific's new walk-in Protected Work-Aisle. They're heated, they're weatherproof, they provide plenty of elbow room, and they're safe. Their unobtrusive and good-looking lines assure a welcome reception in any location. Investigate the Protected Work-Aisle now. Write Federal Pacific Electric Company, General Offices: Dept. 338, Newark 1, New Jersey—The Best in Electrical Control, Distribution and Power Equipment.

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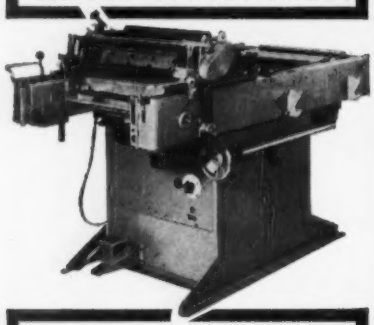

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Proceedings of the Eastern Joint Computer Conference

Publication T-114 consists of 38 papers on modern computers: their objectives, designs, and applications.

The papers and discussions were presented at the Eastern Joint Computer Conference in Philadelphia, Pa., December 3-5, 1958, which was sponsored by the AIEE, the Association of Computing Machinery, and the Institute of Radio Engineers.

T-114 may be purchased from the **Order Department, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y.,** for $4.00. Additional copies may be ordered at $3.00.

NOTE: In the December 1959 issue of *ELECTRICAL ENGINEERING*, page 33A, the price for T-114 should have been listed as $4.00. *Additional* copies ordered are $3.00.

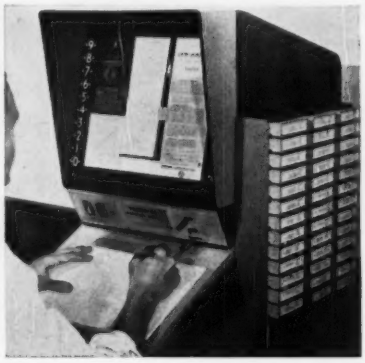
Industrial Notes...

Autonetics
New York, N. Y...

Eastern sales and service of industrial products manufactured by Autonetics, a division of North American Aviation, Inc., will be headquartered in new offices at 717 Fifth Ave., New York, N. Y. The new office is part of Autonetics' expanded program for the production, sales, and service of industrial electronic equipment. Initial emphasis has been placed on the marketing of the Recomp general-purpose digital computer to the scientific and industrial fields.

Rogers Publishing Co.
Englewood, Colo. . .

A product of Technical Services Division, Rogers Publishing Co., 3946 S. Broadway, Englewood, Colo., called VSMF (Vendor-Specs-Microfilm-File) Microfilm Catalog Service, contains engineering specifications on all types of components and materials used in the construction of missiles and aircraft. The system makes use



of microfilm and a film projection device developed by the Recordak Corp., subsidiary of Eastman Kodak Co. The reading device "blows up" the miniature picture from the film into a full-size image in front of the operator, where it may be easily studied or where a direct copy of the displayed information may be made with equipment provided for this purpose.

Gilliland-NRI
Oakland, Calif. . .

A paper-tape to magnetic-tape converter that reduces costly computer information loading time eliminates the intermediate conversion of paper tape to cards, making possible the off-line conversion of paper tape directly to IBM *650* and *704* magnetic tape at 300 characters per second. The converter automatically generates the required magnetic tape format structure—longitudinal parity bits, record and file spaces, end-of-file marks—without special paper tape codes. Information on 7- or 8-channel paper tape is recorded on ½-inch oxide magnetic tape ready for playback on the IBM transport. Facilities are included for paper tape parity checks and format checking. Gilliland-NRI, 3124 E. 14th St., Oakland 1, Calif.

ELIN Division
Burbank, Calif. . .

The name Electronics International Co. has been changed to ELIN Division of International Electronic Research Corp. This division has been and will continue manufacturing precision power oscillators, voltage calibrators, and multiphase precision power sources. A complete brochure on the ELIN instrumentation line is available on request by writing ELIN Division, International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif.

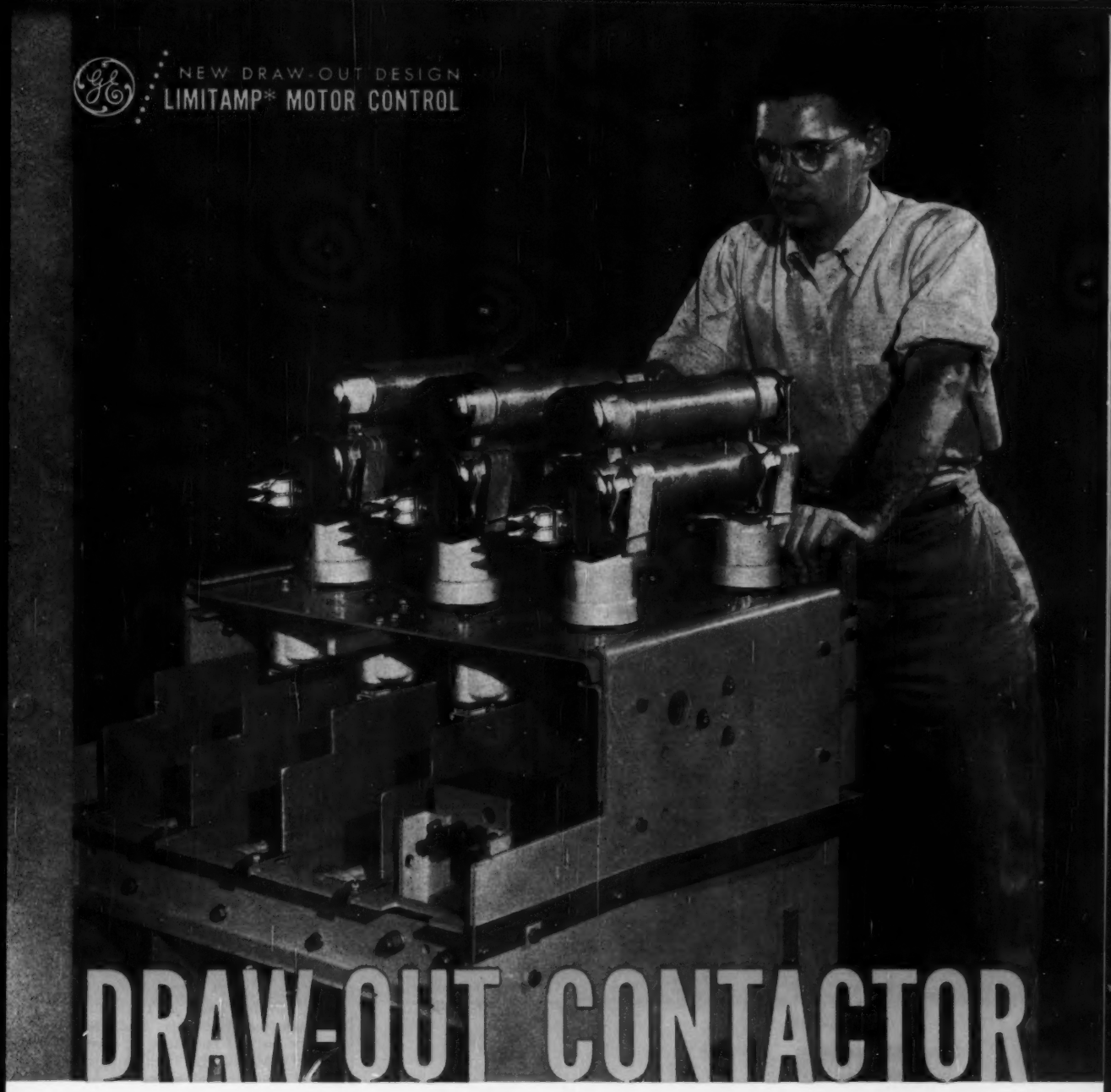
Allis-Chalmers
Milwaukee, Wis. . .

An entire outdoor housing for Allis-Chalmers metal-clad switchgear is made of extruded aluminum panels, developed in conjunction with the Reynolds Metals Co. Aluminum extrusions are snapped together to form a maintenance-free structure for outdoor use. Called the Aluma-Clad switchgear housing, the new type structure requires no paint to protect it from weather wear. Aluminum surfaces do away with the need for primers, enamels, sealers, and also the task of periodic repaintings. Adding to the strength and rigidity of the over-all structure, the snap-tight interlocking panel edges form a permanent, leak-proof joint. Two extrusions to the running foot with dual interlocking edges contribute to increased floor loading strength as well as to wall

rigidity. Lighter weight and modular construction speeds handling and installation at the job site. The need for cranes to handle placement of panels is eliminated. Minor adjustments can be completed with ease.

(Continued on page 34A)

NEW DRAW-OUT DESIGN
LIMITAMP* MOTOR CONTROL



DRAW-OUT CONTACTOR

. . . cuts Limitamp control installation time

Rated 2300- to 4600-volts for a-c motors up to 3000 hp.

A draw-out contactor which automatically connects or disconnects as it is rolled in or out of the enclosure!

This is just one of the revolutionary design features in General Electric's new Limitamp motor control . . . a new design which cuts installation time in half!

During installation the contactor is easily withdrawn, leaving ample room to enter the enclosure, pull both motor and incoming power cables and make connections. When cables are connected, barriers are placed in position to seal off incoming line cable and a-c bus. The motor cable—located in its own raceway—is completely accessible when the starter is de-energized.

As the contactor is rolled back in, stab-on contacts automatically plug into the de-energized power circuit. At the same time, control power is automatically engaged. Installation time is held to a minimum.

Ask your G-E Apparatus Sales Engineer about other advanced-design installation, operation, performance and maintenance features of new Limitamp control. Or, write Sect. 783-11, General Electric Co., Schenectady, N. Y. for Bulletin GEA-6893. Industry Control Dept., Salem, Va.

Progress Is Our Most Important Product

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NEED MOTOR CONTROL CENTERS QUICK?

ORDER NELSON
Quick-trol
and get delivery in
1/2
the usual time

Find Your Nearest NELSON Representative in the 'Yellow Pages'
See "ELECTRIC EQUIPMENT MANUFACTURERS"

QUICK SHIPMENTS

Nelson cuts delivery time 50%. Units assembled from off-the-shelf assemblies.

MANY COMPONENTS

Quick-trol units are available with comb. starters, switch or CB type, sizes 1-4 FVNR, sizes 1-3 reversing; Main or branch circ. breakers or fused switches; Lighting panels up to 24 circuits.

SAVES TIME

Quick and *easy* installation due to
- Big 35 sq. in. vertical wiring gutters
- Front access continuous horizontal wiring gutter
- Easy access to main lugs

QUALITY FEATURES

- Attractive, ruggedly constructed cubicles
- Main bus at center for less current density in vertical bus
- Rigid 25,000 AIC bus bracing
- Reliable components throughout

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

Industrial Notes

(*Continued from page 32A*)

Librascope
Glendale, Calif. . .

A simple production technique which simplifies wiring of large terminal bays used in computers has been announced

by the Industrial Department, Librascope, Inc., 808 Western Ave., Glendale, Calif. Rather than requiring a wirer to stand at a cabinet and wire the entire bay, the connectors have been grouped in three panels which are individually wired at benches where the worker may sit and work under optimum lighting conditions. At the completion of wiring, the separate units are bolted into the cabinet to form one large bay, and interconnections between the separate panels are quickly completed. The 2-stage assembly permits a greater number of wirers to work on the terminal bays. It reduces fatigue and errors during the placement and connection of the thousands of insulated wires which must follow a direct point-to-point path from one terminal to another. At completion of wiring, all bays are tested automatically by specialized equipment which checks continuity and potential of all connections in the cabinet.

Texas Crystals
Ft. Myers, Fla. . .

The new plant of Texas Crystals, a division of Westronix, Inc., has been placed in full operation at 1000 Crystal Dr., Ft. Myers, Fla. The plant is of fireproof concrete and masonry construction and provides a total working space of over 8,000 square feet. The building provides added facilities for crystal-sawing, processing, warehousing, and shipping.

American Meter Co.
Fullerton, Calif. . .

A 65,000 square-foot addition, which more than doubles the plant's size, will house all production, customer service, warehousing, and research operations of American Meter Company's Reliance Regulator Division. The new production facilities are to enable the company to meet the increased demand for pressure regulation equipment created by the continued growth of the gas industry in the West.

(*Continued on page 36A*)

* Reg. Trade-mark of General Electric Company

Quicker and Better this way

Integral build up and stress cone In new O-B Pothead produce perfect results in less time

These men are installing the lower paper buildup of a new 230-kv O-B capacitor-graded pothead. See the band on the lower end . . . this is the stress cone. The two are integral. A perfectly-formed stress cone is now merely a by-product of installing the buildup.

At the factory, a foil ribbon is firmly attached to the surface of the paper. By varying the angle slightly, a true logarithmic flare is imparted when the paper is wrapped into a tube. Much time is saved. Better results are achieved.

Ingenious design of the new O-B pothead has moved many critical operations from the field to the factory . . . where they belong. Not only does this assure a more precise end-result, but it permits easy installation in an ordinary working day. Thus cable exposure is reduced to a minimum.

Present production of O-B capacitor-graded potheads is in the range of 115-230 kv, inclusive, for all types of underground cable. If your plans involve such systems, investigate this newest development in terminal equipment.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass HOLAN

PORCELAIN INSULATORS · LINE HARDWARE · CAPACITORS · LIGHTNING ARRESTERS
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Does it still hold its stimulating challenge? Are all of your abilities being utilized? Have you gone far enough, fast enough?

Today, Motorola's rapid expansion in the Chicago area has created an immediate need for experienced engineering talent. Never before have secure career opportunities been more abundant, challenging and rewarding—in a wide selection of electronic fields.

A picture-packed 36 page booklet is waiting for you. It details the work, the people, the living at Motorola. If you are sincerely seeking broader career opportunities and responsibilities, investigate Motorola immediately.

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- Device using kylstrom, traveling wave tube and backward wave oscillator
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- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

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Chicago 51, Illinois

EQUAL JOB OPPORTUNITY For All Qualified Applicants

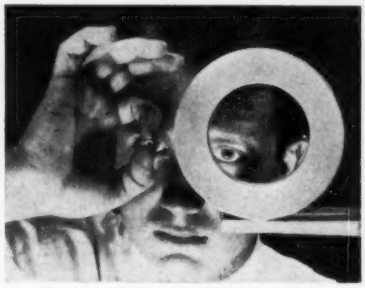
MOTOROLA Inc.

Industrial Notes

(Continued from page 34A)

Allegheny Ludlum Pittsburgh, Pa. . .

Acting like tiny telephone operators in space, subminiature and microminiature filters, which are used to transmit and receive information from missiles and satellites, are growing smaller and smaller, but better and better. Pictured is one of the smallest (0.260 inches in diameter) and



largest (5.218 inches in diameter) of the powdered cores used in electronic equipment. These special cores are made by The Arnold Engineering Co., a subsidiary of Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.

Tally Register Corp. Seattle, Wash. . .

New offices and manufacturing area, located at 1310 Mercer in the Westlake district of Seattle, Wash., contain 17,500 square feet; the site allows for an expansion to 35,000 square feet. Complete facilities are included for the manufacture of equipment meeting both military, scientific, and industrial needs.

Engelhard Industries, Inc. Newark, N.J. . .

A gold-antimony alloy with significant improved properties for transistor manufacturers has been developed by the Baker Contact Division, Engelhard Industries, Inc., 113 Astor St., Newark, N.J. Available in rod or whisker wire in diameters from 0.25 inch down to 0.001 inch and in sheet down to 0.0015 inch thickness, the new material consists of high purity gold containing 1% antimony and is unique in the completely homogeneous dispersion of the antimony-rich phase throughout the gold matrix. Alloy no. *1549*, as it is designated, is designed for use in imparting a controlled impurity (antimony) into a semiconductor crystal, usually silicon, by evaporation techniques. In this method of crystal doping, the alloy is heated until the antimony boils off, creating an antimony atmosphere from which the crystal picks up the desired impurity.

(Continued on page 38A)

another mark of reliability

No matter what trademark you choose from the AMP catalog, you pick a mark that stands for reliability. AMPOWER, the latest in the family of AMP trademarks, embraces top quality terminals for the larger wire size range . . . conforming to NEMA specifications.

To get the finest electrical/electronic circuit termination products, to get the finest application tooling and the surest, most economical route to enduring reliability, always specify one of the trademarks of AMP INCORPORATED.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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* *Machine tools to be shown at European Machine Tool Show, Hanover, September 11-20, 1960*

PERFORMANCE AND PROTECTION OF AERIAL CABLES

February 1958

This informative 44-page publication consists of six transactions and conference papers with discussions and closures on cable insulations, various practices in the installation of these cables, and the results of actual field tests to determine some of the phenomena which have taken place.

The papers were presented at the 1957 Summer General Meeting of the American Institute of Electrical Engineers, Montreal, Que., Canada, June 24-28, 1957.

Publication S-102 is available for $2.50 from the Order Department.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
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ENGINEERS AND MATERIALS INSPECTORS WANTED

TVA has openings on a large hydro- and steam-electric program for experienced civil, structural, electrical, and mechanical engineers in its Division of Design located in Knoxville, Tennessee, and for materials engineers and inspectors of materials located in various district offices, principally in the north and east.

These positions are at the following grades and rates of pay:

Civil, Mechanical, Electrical, and Materials Engineers, grades SD-2 and -3 **$6200-$7150**

Inspectors of Materials, grades SE-5 and -6 **$5825-$6625**

The engineering jobs require a college degree in engineering or its equivalent with from one to three years of experience in design and specification work, or in inspection and testing work for materials engineers. The inspector of materials jobs require some college training in engineering or equivalent training and experience in making engineering inspection and tests of mechanical, structural, and electrical equipment and materials.

All jobs carry automatic within-grade increases for satisfactory service, liberal vacation leave, sick leave, and retirement, hospitalization, and insurance benefits.

Write to:

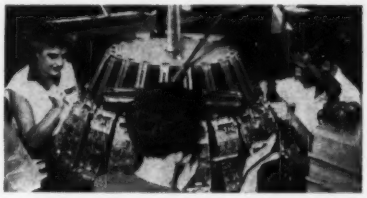
TENNESSEE VALLEY AUTHORITY, Division of Personnel, Knoxville, Tennessee.

Industrial Notes

(Continued from page 36A)

The Martin Co. Baltimore, Md. . .

A rotary wheel has replaced the standard assembly line work bench in assembling small missile electric and electronics components at The Martin Company's Baltimore Division, Baltimore 3, Md. The rotary wheel is said to handle assemblies from 2 inches square up to sizes 14 by 18 inches. Each of 10 wheels now in operation has the capabilities of a conveyor belt with associated equipment, yet requires no more floor space than a standard work bench. Each wheel has



three work spaces for assembly personnel and 24 assembly positions. The individual operators work as a team, each operator accomplishing one-third of the work assigned to the particular wheel. Operation is controlled by a Ledex stepping relay which is basically a power-operated rotary switch that permits remote control of the various electric circuits.

Permali, Inc. Mt. Pleasant, Pa. . .

A unique plastic material manufactured by Permali, Inc., Mount Pleasant, Pa., is being used for the insulating structural members in a new and versatile impulse generator. This material, which has a tensile strength of 30,000 psi, is made by temperature- and pressure-bonding selected, thin, wood veneers previously impregnated with a special synthetic resin. The impulse generator is installed in the enlarged Electrical Laboratory of the Joslyn Manufacturing & Supply Co., Chicago, Ill. The Joslyn firm is a major producer of electric transmission line equipment.

Thompson Ramo Wooldridge Inc. Cleveland, Ohio . . .

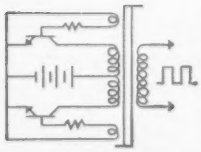
Thompson Ramo Wooldridge Inc. (TRW) has acquired Radio Industries, Inc., a leading producer of transformers and ceramic disc capacitors. The company, with headquarters in Des Plaines, Ill., and other plants in Chicago and Marshal, Ill., employs approximately 750 people in these three locations. It will continue to operate autonomously as a subsidiary of TRW. No changes in management are contemplated.

(Continued on page 42A)

INCREASED RELIABILITY PLUS HIGHER OPERATING TEMPERATURES with Westinghouse Silicon POWER Transistors*

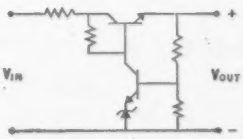
Westinghouse 2N1015 and 2N1016 Silicon Power Transistors offer positive, *proved* benefits to designers of inverters, series regulators, and A.C. Amplifiers.

INVERTERS...



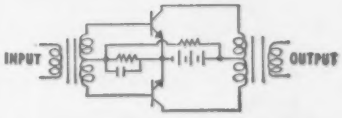
Extremely low saturation resistance (typical .3 ohms) minimizes power losses in the transistor. High temperature (150°C T_j max.) operation permits compact inverter designs for missiles, aircraft, and other military equipment.

SERIES REGULATORS



High voltage ratings and high temperature operation, plus internal power dissipation of 150 watts made possible by low thermal resistance of .7°C/watt make the 2N1015 and 2N1016 an ideal choice for constant voltage and constant current regulators.

A.C. AMPLIFIERS...

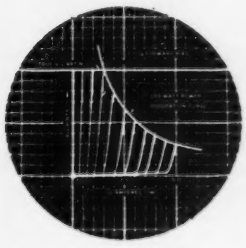


Perfect choice for high power audio and A.C. Amplifier applications, thanks to their high power dissipation capabilities and common emitter frequency response to 20KC.

PLUS TRUE VOLTAGE RATINGS...

guaranteed by 100% power testing. Means you can operate these transistors continuously at the V_{CE} listed for each rating without the risk of transistor failure.

Production quantities of Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both are available in 30, 60, 100, 150, and 200 volt ratings for immediate applications. Contact your local Westinghouse Apparatus Sales Office, or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Penna.



*Designed to meet or exceed military specifications and currently being used in many military, industrial, and commercial applications.

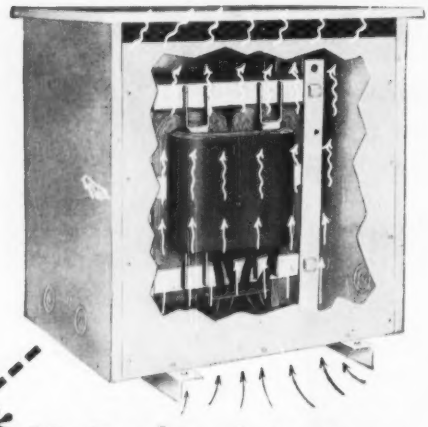
Type	V_{CE}*	B (min)	R_s (max)	I_C A (max)	T_j max. operating	Thermal drop to case (max)
2N1015 2N1015A 2N1015B 2N1015C 2N1015D	30 60 100 150 200	10 @ I_C=2 amp	.75 ohms @ I_C=2 amp I_B=300 ma	7.5	150°C	.7°C/W
2N1016 2N1016A 2N1016B 2N1016C 2N1016D	30 60 100 150 200	10 @ I_C=5 amp	.50 ohms @ I_C=5 amp I_B=750 ma	7.5	150°C	.7°C/W

*TRUE voltage rating (The transistors can be operated continuously at the V_{CE} listed for each rating.)

YOU CAN BE SURE...IF IT'S Westinghouse

THIS is why Acme Electric Class H Transformers Operate...

√ Cooler
√ More Quiet
√ Last Longer *



* Air Rushes into Base . . . Cools Core and Coils . . . Comes Out Top

Heat, normally generated by core and coil assembly is conducted from the surface of the core and coils to the surrounding air.

When this air temperature becomes higher than ambient temperature level, it rises to the top of the transformer and is emitted from transformer thru vents in top of case, automatically causing a flow of cooler air to the base thus setting up a natural forced-draft cooling system.

When you want the economy of Class H insulation, long dependable service and normal quiet operation install Acme Electric dry-type AIR-COOLED transformers. Write for Bulletin AC 100.

ACME ELECTRIC CORPORATION
223 Water Street Cuba, N. Y.
West Coast: 12822 Yukon Avenue Hawthorne, Calif.

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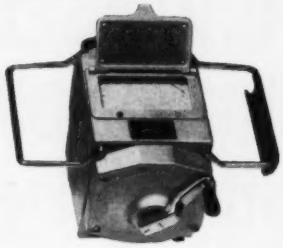
Acme ACME Electric
TRANSFORMERS

High Efficiency
HITACHI INSULATION TESTERS



Available ranges: from 100V-10 Megohms to 2000V-5000 Megohms.

Also: **Type E-17**
Dual ratings: up to 1000V-200 Megohms-100 Kilohms.

Dual voltages: 500/250V-100/50 Megohms.

Special Features:

Indicating movement is unique type of Ratiometer of core-magnet design, with extremely high torque to weight ratio. Shielded from external fields. Generator with ball bearings. Precision gears for hand cranking.

Also supplied with motor drive attachment or Rectifier for panel mounting.

For Bulletin and Prices write to:

EDDO PRODUCTS CORPORATION,
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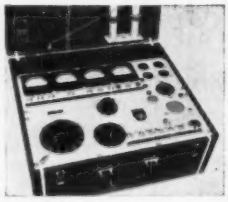
Tel. Yukon 6-5573

Representatives in most parts of USA.

THYRATRON AND RECTIFIER TUBE TESTER

Model #JB-16C



1. Thyratron functions in instrument circuit with meters indicating operating points permitting quick comparison with tube chart.
2. Automatic indication of critical grid volts (trigger points), automatic indication of critical grid current.
3. Direct reading arc-drop voltmeter.
4. All common industrial tubes accommodated from 0.1 thru 16 amp.
5. Tubes can be tested wherever line voltage is available. Permits bench testing of tubes.
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7. Input 105 to 130 v a-c, 1 phase, 60 cycle. Range 1 to 16 amp Tube.
8. $780.00 net to user, F.O.B. Kenosha.

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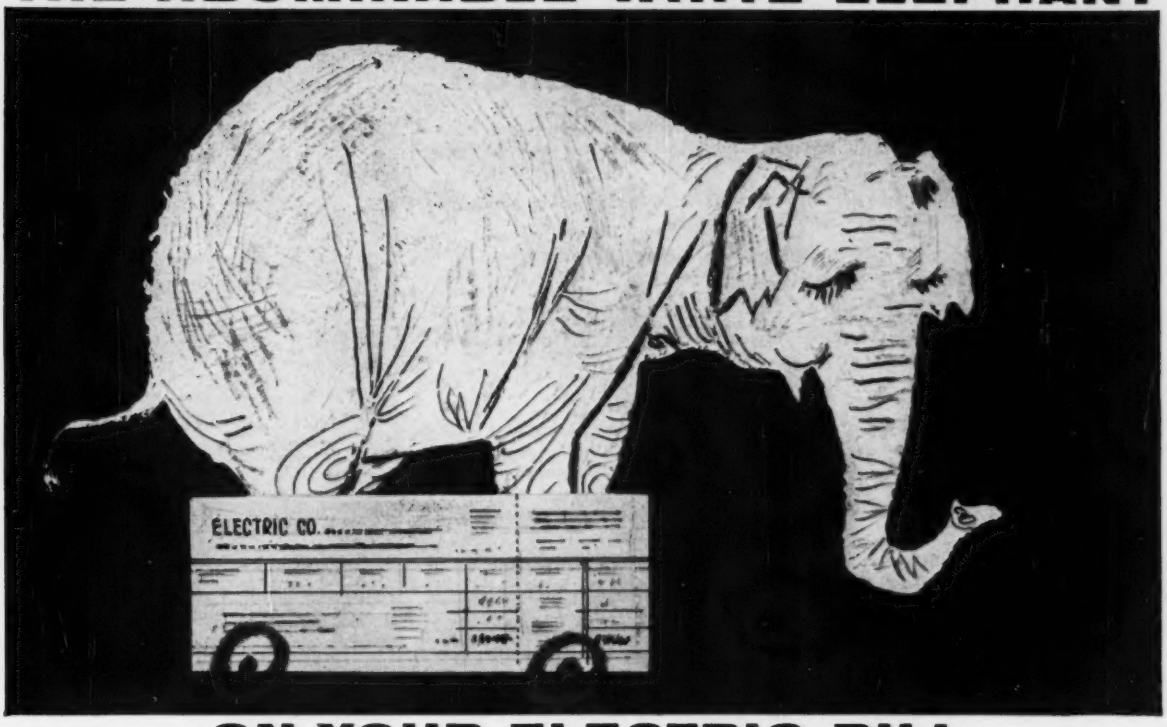
DESIGN ENGINEER

Manufacturer of power and communications line equipment has opening for an EE with experience in the design of power switching equipment. This job is Senior Project level.

Location at engineering headquarters in small, pleasant mid-west community with AAA school system.

Starting salary based on qualifications. Merit increases, annual cash bonus, and profit sharing. Replies confidential. Send resume of age, education and experience to Box 71.

THE ABOMINABLE WHITE ELEPHANT



ON YOUR ELECTRIC BILL

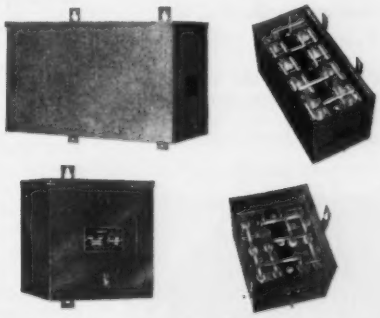
IF YOUR ELECTRICAL SYSTEM is burdened with a low power factor, you're paying for electricity you can't use... you're giving up electrical capacity you may need.

The motors and other inductive devices in your plant use both kilowatts (working current) and kilovars (magnetizing current) in order to run. The kilowatts you buy. The kilovars you can best supply yourself. *The more you supply, the higher your power factor, and the less you pay the electric company.*

Sprague Unipak* Power Factor Correction Capacitors are the most economical and efficient means of supplying your own kilovars. You put them right where they're needed . . . *at the motors.* Your electric company does not have to send as many kilovars all the way from the power plant, so they charge you less. Your wiring does not have to carry the extra kilovars to the load, so it can handle additional loads.

Actual power bill savings experienced in many plants have more than paid for the Power Factor Capacitors in less than a year's time . . . in some cases, in less than six months. And as an added dividend, these capacitors have also increased the power handling capacity of many plant distribution systems by an average of 20%.

You, too, can reduce costs . . . increase your plant's electrical capacity . . . by installing Sprague Unipak Power Factor Correction Capacitors.



If you'd like *free* assistance in making a survey of your electrical installation to see how *you* can save money with Sprague Unipak* Power Factor Capacitors, write Industrial Capacitor Division, Sprague Electric Co., 321 Marshall St., North Adams, Mass.

*Trademark

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at all levels in the fields of precision electronic components and analytical instrumentation for engineers and scientists with degrees in engineering or physical science. Some of our specific needs include project engineers, senior scientists or engineers, product engineers and senior electronic engineers. We also have openings for exceptional recent graduates.

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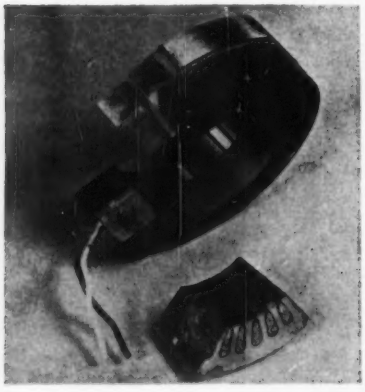
Industrial Notes

(*Continued from page 38A*)

Houghton Laboratories, Inc.
Olean, N. Y. . .

A shock resistant epoxy casting system, Hysol *6622*, has been developed by Houghton Laboratories, Inc., Olean, N. Y. Especially designed for embedding electric



motor stators and transformers, it is also suitable for casting or potting large masses where exotherms cannot be tolerated. It is excellent for potting circuits and transformers having strain sensitive elements. For complete details write for the new 6622 product bulletin.

Accurate Specialties Co.
Woodside, N.Y. . .

As part of their expanded program of producing special components for the electronic industry, Accurate Specialties Co., Inc., has formed a controlled subsidiary called Metalizing Industries, Inc., located at 338 Hudson St., Hackensack, N. J. Metalizing Industries, Inc., will produce a complete line of metalized ceramic components including metalized solder seal terminals, micromodule wafers, printed circuits, metalized ceramic housings for hermetically sealed resisters, capacitors, diodes, and rectifiers.

Minneapolis-Honeywell
Minneapolis, Minn. . .

Full-scale commercial production of precision ceramics components for military and industrial applications has been begun in expanded plant facilities which will enable the firm to quadruple shipping rates over the figure achieved in a previously used pilot production operation. As a result of several years of research, Honeywell has developed production techniques enabling it to supply close-tolerance ceramics parts for other companies with similar requirements. Minneapolis-Honeywell Ceramics Laboratory, 1885 Douglas Dr., Minneapolis 22, Minn.

General Radio Co.
West Concord, Mass. . .

An innovation in exhibits, a traveling instrument display-demonstration vehicle, designed by the General Radio Co., has been developed to bring a full complement of the latest deevlopments in electronic measuring equipment directly to local government agencies, laboratories and industry, and educational institutions.

Courtesy General Radio

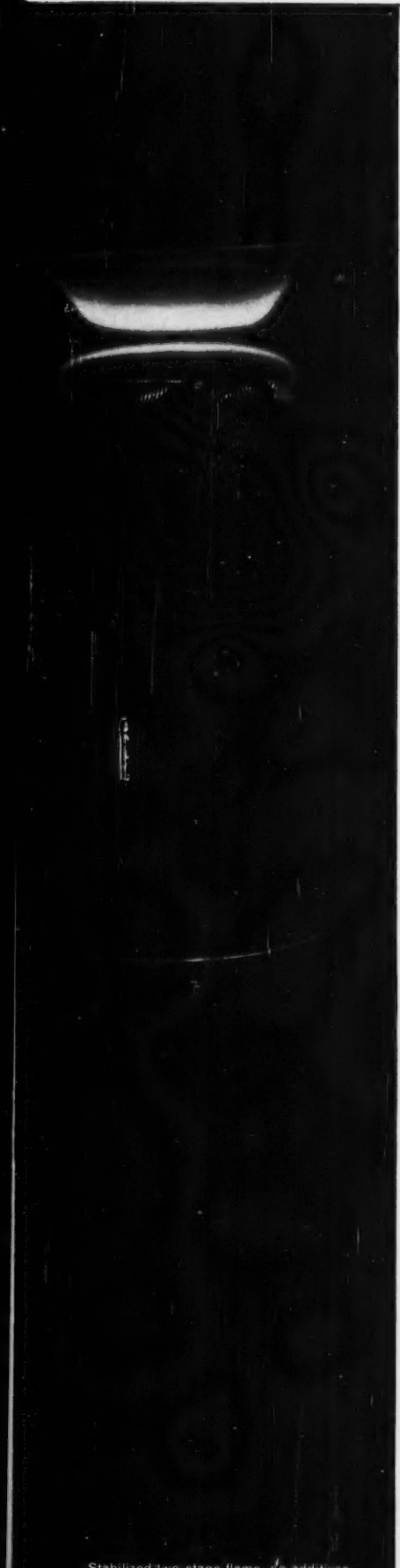
The car, a modified station wagon, carries over 1,500 pounds of instruments mounted on six collapsible tables, which can be set up in an hour by a 3-man team of engineers. The wide assortment of test apparatus which sets up as six operational displays is packed into the car by collapsing the tables onto three moving dollies, and fitting bundles of literature, signs, and miscellaneous accessories into a two-decker rolling box.

Metalclean Equipment Co.
Bala Cynwyd, Pa. . .

A new automated ultrasonic process which integrates cleaning and degreasing with high-speed production of metal parts is incorporated in the design of an advanced machine now in production by Metalclean Equipment Co., P.O. Box 177, Bala Cynwyd, Pa. Called AutoSonex, it processes machined and sheet-metal parts as fast as they come off automatic fabricators. The Metalclean machine may revolutionize most metal parts processes by combining the separate operations of production and cleaning. As the firm points out, the cleaning in itself heretofore has amounted to a substantial operation.

The Bristol Co.
Waterbury, Conn. . .

The Bristol Co. is offering a new ball-point pen for the company's Dynamaster electronic recording and controlling instruments. The pens give excellent results at chart speeds from ¾ inch per hour to 240 inches per minute, with instrument balancing speeds from 0.4 second to 24 seconds. Ink contained in the ball-point cartridge is available in several colors, and it is reproducible on standard office copying machines. An attachment is offered for installing the new ball-point pen on instruments which now have standard pens.



Stabilized two-stage flame, no additives

One of a series

The burning question of cool flames

Between the brief stage of not burning and burning, many hydrocarbons react with oxygen at temperatures well below that of normal flame combustion. But the reactions are usually transient and hard to analyze. At the General Motors Research Laboratories, we have been able to investigate the *effect of chemical additives on cool preflames.*

To do this, the almost invisible cool flames are stabilized for hours in a flat-flame burner, permitting careful examination of the retardation or acceleration effects of the additives. From more than twenty additives studied, experimental results indicate that some chemicals affect combustion through the mechanism of preflame reactions. We are now accumulating new information on these additives' mode of operation. For instance: emission spectra support the conclusion that tetraethyl lead reacts with the oxygenated compounds formed in cool flames to yield lead oxide vapor. These findings of when and how lead oxide is formed are important in resolving a current controversy of science — the combustion behavior of tetraethyl lead.

Studies such as this may lead to more economical and effective means of controlling unrestrained combustion — such as "knock" in reciprocating engines. The work is typical of GM Research's effort to provide useful information for a moving America. And in this way continue to keep our promise of "More and better things for more people."

General Motors Research Laboratories

Warren, Michigan

Iron carbonyl, an antiknock

Ethyl nitrate, a proknock

Iron carbonyl retards, ethyl nitrate accelerates central portion of cool flames.

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Soft Rubber Boots Prevent Injury to men or machines. A-B pendant stations are available with from 2 to 16 units, plus emergency stop unit in bottom of enclosure.

Allen-Bradley offers the

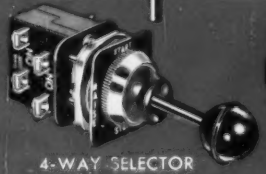
MOST COMPLETE LINE

of oiltight heavy-duty

CONTROL UNITS

The wide selection of Allen-Bradley Bulletin 800T push buttons and control units will enable you to satisfy each and every control station requirement. A-B control units and stations have seals to exclude oils and cutting fluids—contacts cannot become fouled. And *all* control units have the popular A-B double break, silver contacts that assure reliable operation—without maintenance. The rugged construction, flexibility, and generous wiring room of Allen-Bradley's Bulletin 800T line are "bonus" features. To get the best in every way—insist on Allen-Bradley. Send for Publication 6090, today.

ILLUMINATED PUSH BUTTON
Space-saving two-in-one control unit.



4-WAY SELECTOR SWITCH
Can also be furnished for 2-way operation.

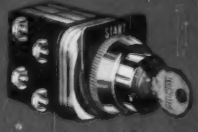
ENCAPSULATED PILOT LIGHT
Transformer type for rugged 6-volt bulb.

PUSH-TO-TEST
Six different color lenses available.

SELECTOR SWITCH
With coin slot operator. Other operators available.

TIME DELAY
Delay adjustable from 0.5 to 5 seconds.

POTENTIOMETER UNIT
Furnished in 2- or 5-watt capacity ratings.



LOCK TYPE
For selector switch or push button operation.

DOUBLE CIRCUIT
Has 2 N.O. or 2 N.C. sets of contacts.

16 UNIT STATION
in die-cast aluminum enclosure. Sheet metal cabinets also available for up to 25 control units.

4-60-RM

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Member of NEMA

QUALITY MOTOR CONTROL

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Yes, Allen-Bradley also makes...

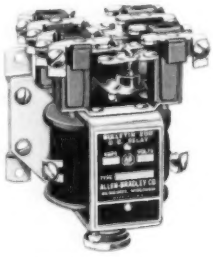
DC Contactors

Here's the only line of DC contactors using the simple solenoid design—with ONE moving part—in all ratings through Size 4. And their double break, silver alloy contacts never need servicing.

BULLETIN 202

DC Control Relays

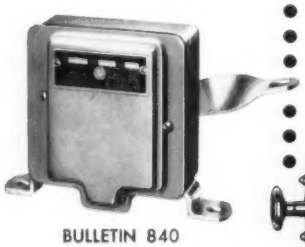
These relays are the counterpart of the Bulletin 700 line of AC relays—of which millions are in service. With only ONE moving part—these relays provide the ultimate in long life and reliability. Like the AC line, they have double break, silver contacts that never need maintenance. Made in a variety of types and with up to 8 switching poles.



BULLETIN 200

Float Switches

This versatile line of float switches is available in a wide range of types and enclosures to handle practically every industrial pumping job. They all feature a snap-action switch mechanism for positive operation no matter how slowly the liquid level changes.

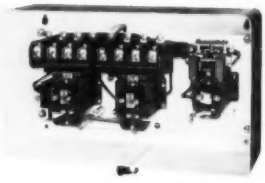


BULLETIN 840

BULLETIN 1209

Loom Switch

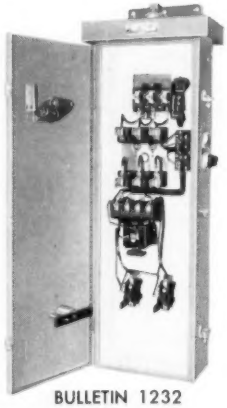
Manual starting switches designed for textile loom service. Design of operating lever makes accidental operation impossible. Lint-tight enclosure eliminates fire hazard.



BULLETIN 1270

Automatic Transfer Switches

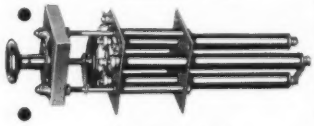
For use where power must be maintained, these panels automatically transfer the load to an auxiliary supply when normal supply fails or falls too low. Transfers automatically when the normal power supply is resumed. Mechanically interlocked.



BULLETIN 1232

Pump Control Panels

Designed for irrigation and oil field pumping applications. Can also be used with outdoor lighting systems. Uses standard A-B Bulletin 709 solenoid starter with manual disconnect switch or circuit breaker in weatherproof enclosure. Available with many optional features.



BULLETIN 410

AC and DC Rheostats

Provide absolutely stepless control over a wide resistance range. Full wattage capacity available at all settings. Sizes to 5400 watts.

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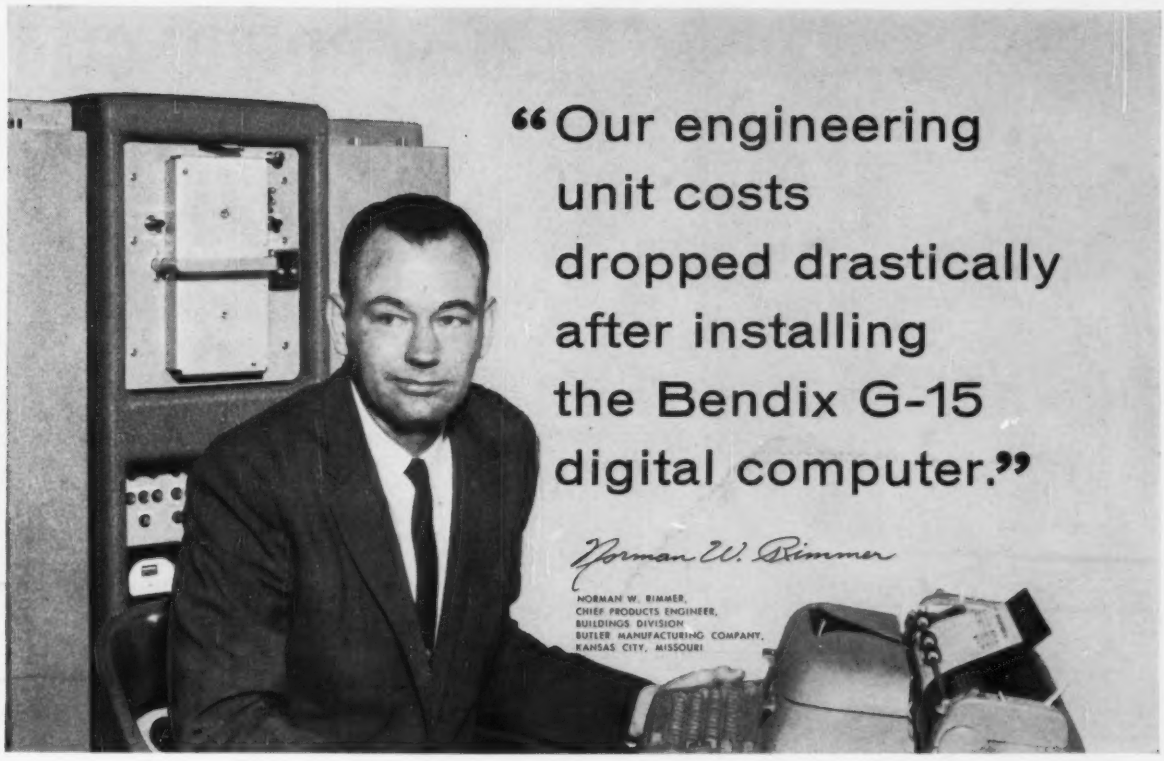
"Our engineering unit costs dropped drastically after installing the Bendix G-15 digital computer."
Norman W. Rimmer
NORMAN W. RIMMER,
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BUTLER MANUFACTURING COMPANY,
KANSAS CITY, MISSOURI

Butler's progressive engineering program requires a fast, versatile, and low-cost computer. It must handle complex structural problems and still be simple enough to be used by engineers with no programming experience. The computer's mission: cut engineering unit costs. *"Our own survey proved that the Bendix G-15 digital computer could best do this job,"* says Mr. Rimmer, *"and it does."*

For Butler, part of the cost-cutting versatility of the G-15 stems from the variety of programming methods they can use. For the solution of repetitive problems at highest speeds, they use the machine language system. With the simplified Intercom 1000 system, the entire staff uses the computer for structural design problems. This versatility also means the G-15 can be used for business data processing as well as scientific and design calculations.

Butler is also pleased with the expandability of the G-15. They know that as their computing requirements grow, they can add magnetic tape units, punched card equipment, digital differential analyzers, plotters, and other accessories. Remember, however, that the basic G-15, which includes a unique photo-electric tape reader-punch and alphanumeric typewriter, is more than adequate for most problems.

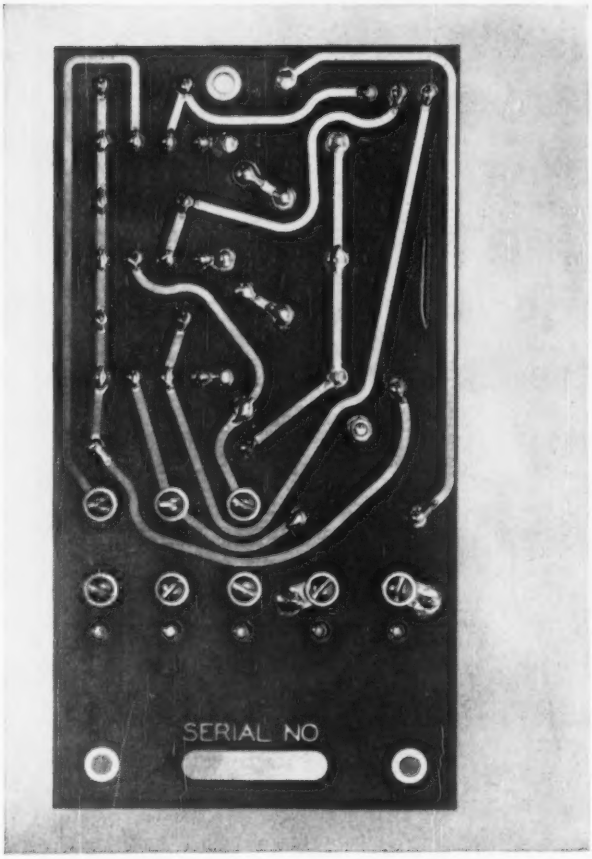
Find out more about this computer — the *only* medium-scale computer in the low-price field. Inquiries regarding specific applications are welcomed.

Bendix® Computer

DIVISION OF BENDIX AVIATION CORPORATION

Dept. K-16

LOS ANGELES 45, CALIFORNIA



High strength-to-weight ratio. This printed wiring board for a phase failure relay (manufactured by Phase-Guard Co., Carnegie, Pa., and distributed by Stradley Engineering Co., Pittsburgh) was designed with CDF Di-Clad 28E (epoxy resin laminated with medium weave glass cloth) for high mechanical strength, very low moisture-absorption, and good insulation resistance. Details upon request.

How CDF Di-Clad® can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Bird COMPANY • NEWARK 86, DEL.

In Canada: 46 Hollinger Road, Toronto 16, Ont.

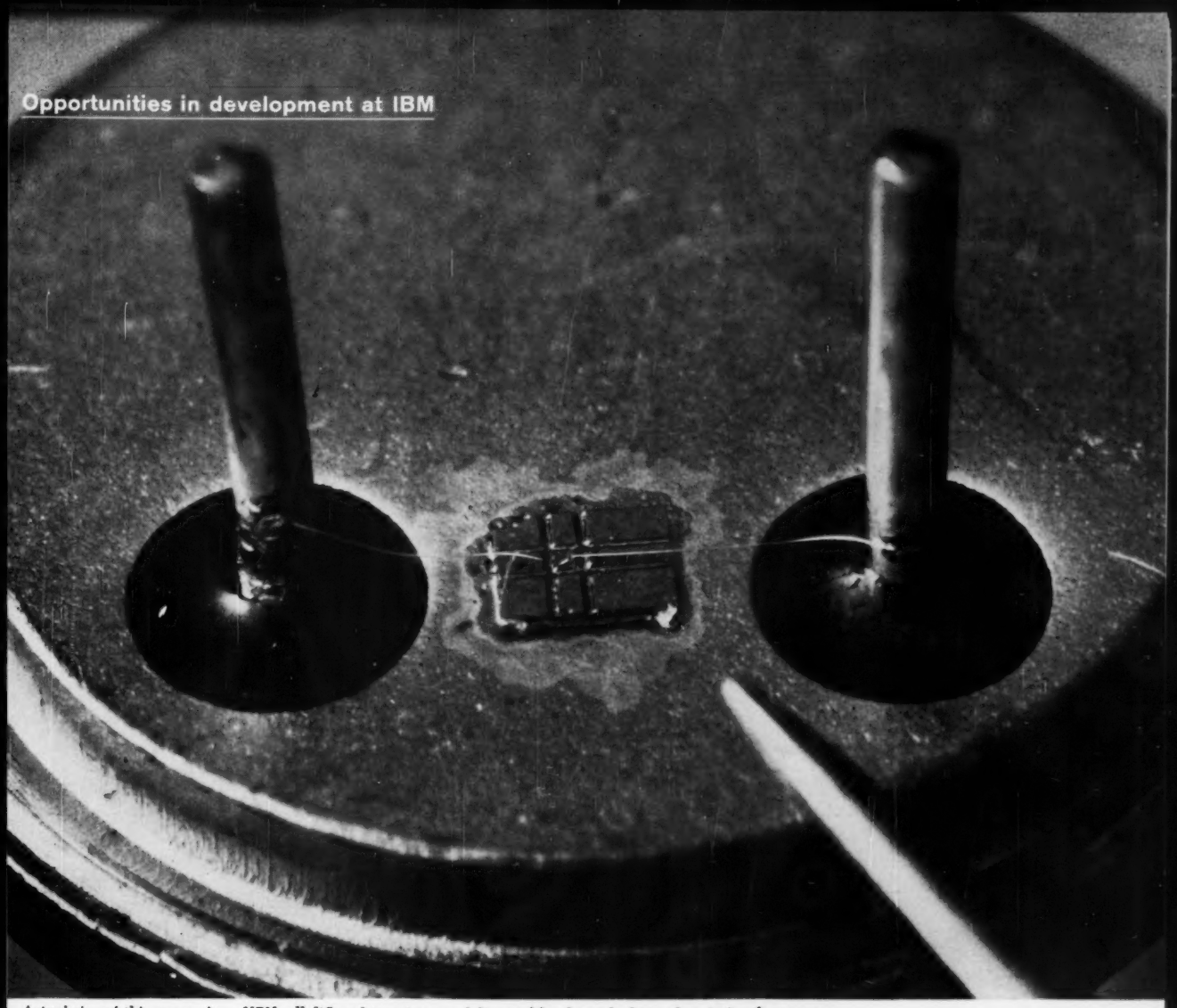
TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark

Opportunities in development at IBM



Actual size of this germanium, NPN, all-diffused transistor as delineated by the etched trenches, is 6 mils square.

Developing all-diffused NPN germanium transistors for UHF

IBM semiconductor specialists have developed this all-diffused NPN germanium mesa transistor which has a frequency cutoff greater than 600 megacycles.

The basis for this development is a process in which a mask of silicon monoxide permits the diffusion of desired "P"-type elements into regions of minute dimensions. This new device, designed for high-speed switching applications, has also been made possible by important advances in germanium "P"-type diffusion processes achieved by IBM engineers and scientists.

The processes used in making this device permit close control of electrical characteristics, high electrical performance and low fabrication costs. This project is typical of the many challenging assignments in IBM's expanding semiconductor programs.

If you'd like to exercise your professional creativity on advanced problems in such areas as semiconductors, microwaves, mathematics, magnetics, human factors engineering, or any other specialties, why not contact us?

Qualifications: A degree in engineering, mathematics, or one of the sciences—plus considerable experience in your field.

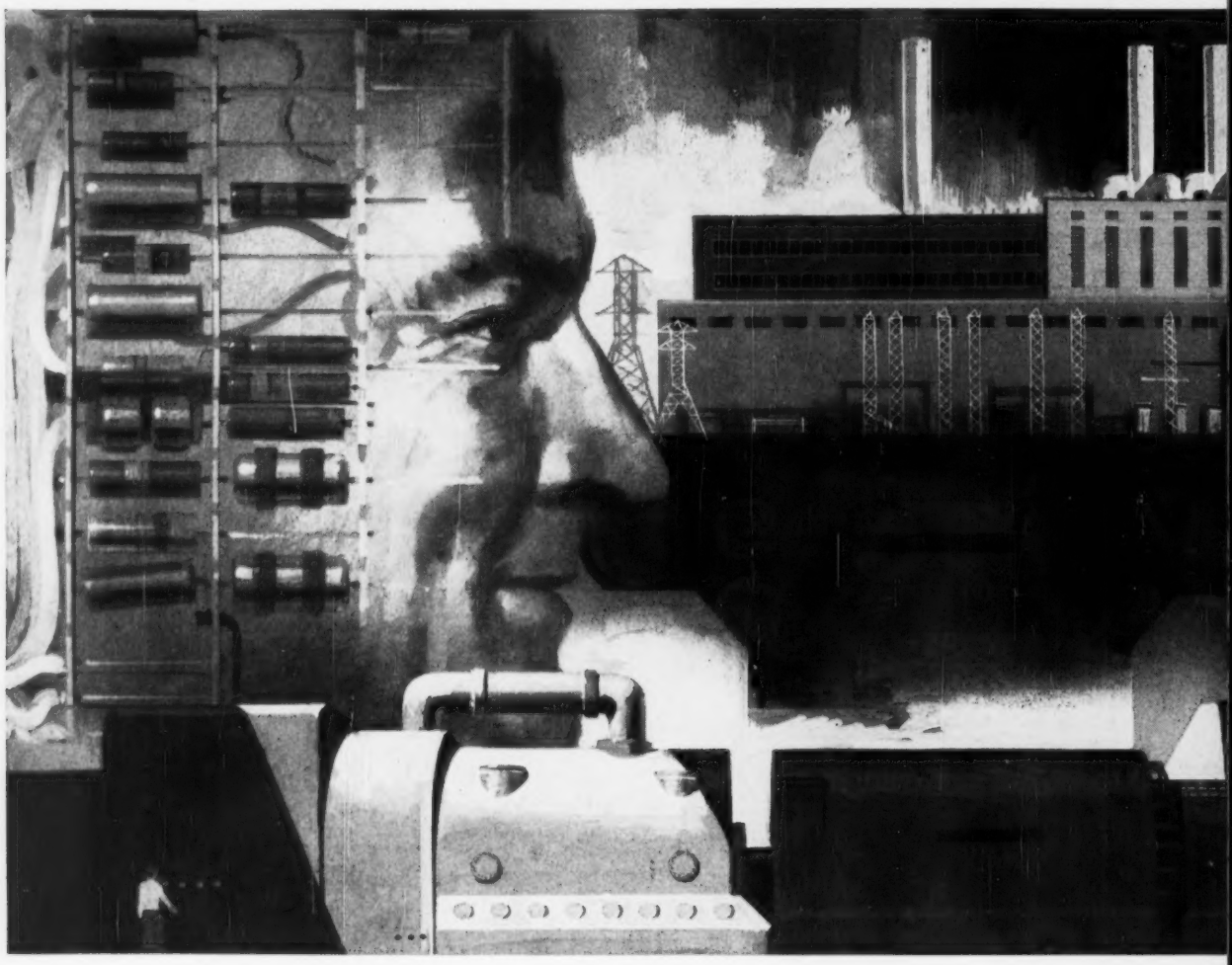
For more details, write, describing your background, to:

Manager of Technical Employment
Dept. 5500
IBM Corporation, 590 Madison Avenue
New York 22, New York

If you plan to be in New York for the IRE Convention, you are cordially invited to visit with IBM's Manager of Technical Employment at 590 Madison Avenue.

IBM.

INTERNATIONAL BUSINESS MACHINES CORPORATION



Westinghouse PRODAC computer-controlled system operates your power plant automatically

Integrates all station controls to increase efficiency, reliability, to decrease operating costs, risks of emergency decisions

The completely automatic power plant is a reality with Westinghouse PRODAC* . . . the system of *PRO*grammed *D*igital *A*utomatic *C*ontrol utilizing an advanced control computer.

The Westinghouse Prodac digital control computer is designed specifically for control systems, with a logic unit and priority director to simplify and expedite making the "thousands of decisions" needed in sequencing and control of a power plant; and to change the sequences automatically whenever needed to start up, shut down, or run the plant at maximum efficiency under normal and emergency conditions.

The Prodac system not only scans and logs system quantities, but through extensive calculations presents them directly in more meaningful terms of heat rates and unit efficiencies. By analyzing these, it can make required changes in controlled quantities to optimize performance of the entire plant.

*Trade-Mark

Prodac ties together other control subsystems such as generator hydrogen control, automatic turning gear, turbine starting speed control, with combustion, feedwater and superheat control.

Above all else, the Prodac system design stresses reliability. In the design of the computer, its application and integration with auxiliary controls, the focus of all engineering considerations is to provide the most complete, most reliable control of the turbine-generator, the boiler and all auxiliaries.

Westinghouse will design and build the complete control system. Westinghouse will, in addition, coordinate the total plant project . . . boiler, turbine-generator, transformers, auxiliaries and other apparatus. The benefits of automation may be extended throughout your generating facility. To integrate all stations, Westinghouse offers a completely automatic dispatching system.

THE WESTINGHOUSE NEW POWER CONTROL AND COMMUNICATIONS DEPARTMENT ENGINEERS AND MANUFACTURES:

Systems: supervisory control
voltage regulator
turbine supervisory
automatic dispatching
automatic power plant control
digital telemetering
scanning, monitor and logging (in plant)
scanning, monitor and logging (remote)

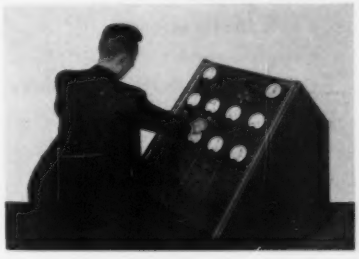
Nuclear: instrumentation and control

Communications: microwave
multiplex
power line carrier

WESTINGHOUSE AUTOMATIC DISPATCHING INCREASES FLEXIBILITY, REDUCES OPERATING COST OF ENTIRE GENERATING SYSTEM. The Westinghouse Automatic Dispatching System provides accurate control of total generation and continuous economic dispatch. Intercompany commitments are maintained while greater economies are realized through accurate computations of transmission losses and incremental loading.

Maximum capability of all machines can be utilized, if necessary, to meet system emergencies without endangering equipment. Massive complexity of today's power systems has forced new levels of accuracy and flexibility. In full consideration of this, Westinghouse offers you an automatic dispatch system that will rapidly repay your investment.

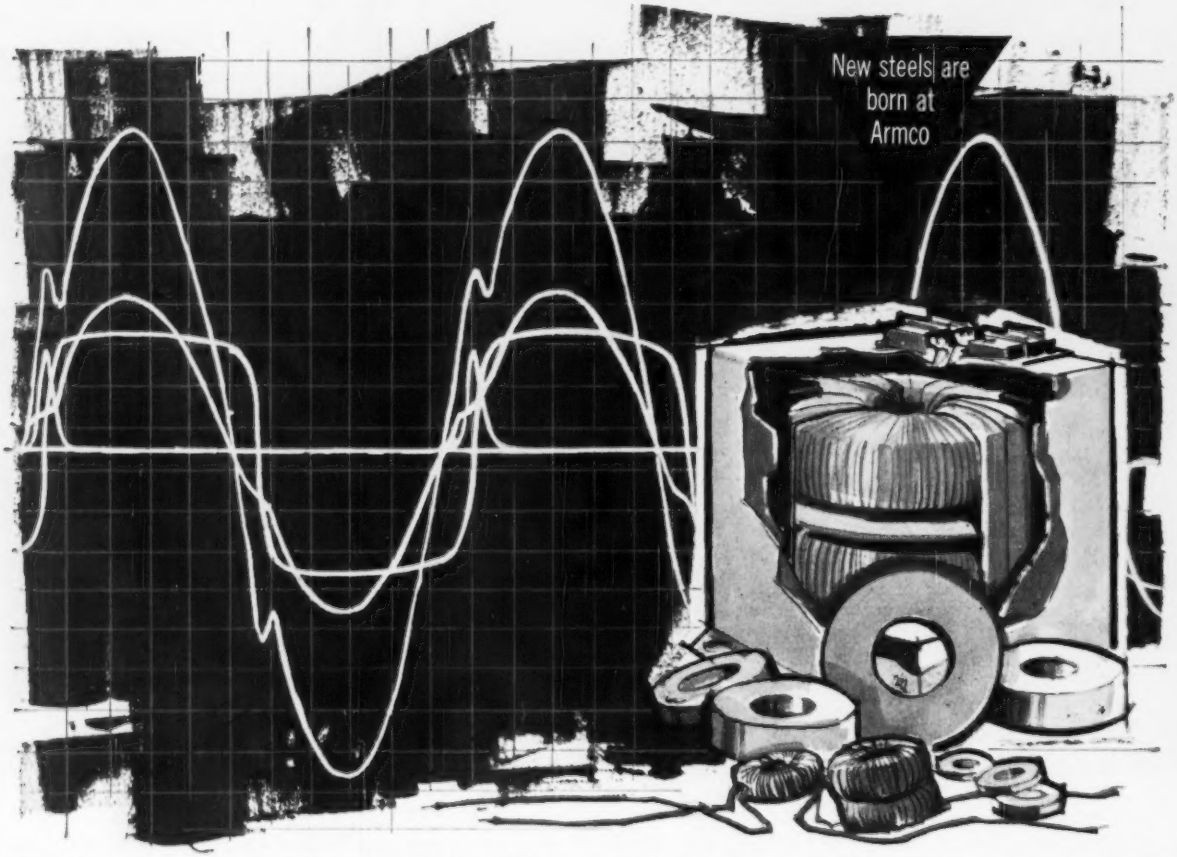
J-60988



YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

CORES CAN BE SMALLER AND LIGHTER, ASSURE LOWER LOSSES, REQUIRE LESS COPPER IF MADE OF ARMCO THIN ELECTRICAL STEELS



Exceptional magnetic properties and extensive design data offer opportunities to improve performance and cut cost of magnetic and electronic units for 400 to 2000 cps and higher frequency service.

Armco Thin Electrical Steels offer you these advantages because they have a unique combination of magnetic and physical properties assured by precise processing and control:

- **Exceptionally high permeability**
- **Low hysteresis loss**
- **High lamination factor**
- **Minimum interlaminar loss**
- **Properties fully developed at the mill**

Available in three different grades, Armco Thin Electrical Steels enable you to select the material most precisely suited to your requirements.

Armco TRAN-COR T— A non-oriented grade, available in 7 and 5 mil thicknesses.

Armco ORIENTED T— Best permeability, in rolling direction, 4, 2, and 1 mil thicknesses.

Armco ORIENTED TS— Super-oriented with exceptionally high permeability, 4 mil thickness.

Use the properties of Armco Thin Electrical Steels to improve performance and reduce both the size and cost of your products. Extensive design data is available to help you utilize their advantages most effectively. Just write Armco Steel Corporation, 1410 Curtis Street, Middletown, Ohio, for complete information.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

Appointment: Countermeasures

SANTA BARBARA is Raytheon's California operation, and is devoted to the Engineering, Marketing, and Production of active and passive ECM and ECCM equipment for aircraft, missiles, and satellites; infrared systems and devices; guidance, mapping, and fire control components.

Countermeasures appointments range from junior to department manager levels. Technical areas are: advanced systems design, microwave components design and application, circuit theory applying backward wave oscillators and traveling wave tubes. Infrared appointments open in reconnaissance and communications systems, circuitry and filter theory, components and servo systems.

Location is excellent. The city of Santa Barbara is a quiet community of 56,000. It has no smog, no million-car traffic. Nearby mountains and offshore islands keep mean temperature 57° – 70° all year. A Spanish setting plays host to theatres, museums, universities and a growing electronics center.

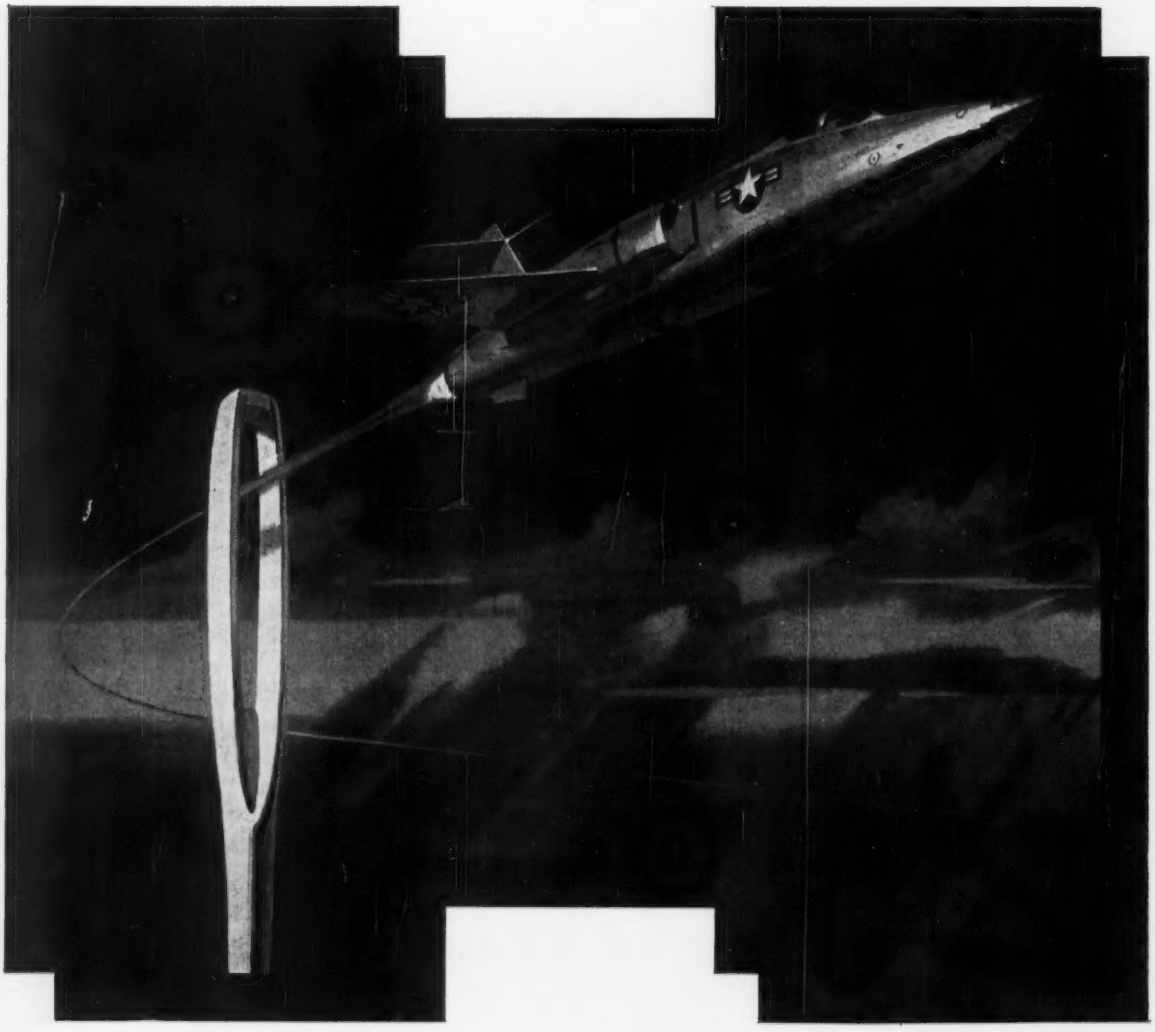
For information on programs coincident with their professional interests, engineers and scientists may write: Mr. Donald H. Sweet, Manager, Management & Professional Recruiting, Raytheon Company, 624 A Worcester Road, Framingham, Massachusetts.

RAYTHEON

EXCELLENCE IN ELECTRONICS

SANTA BARBARA OPERATION
EQUIPMENT DIVISION

How to thread a needle



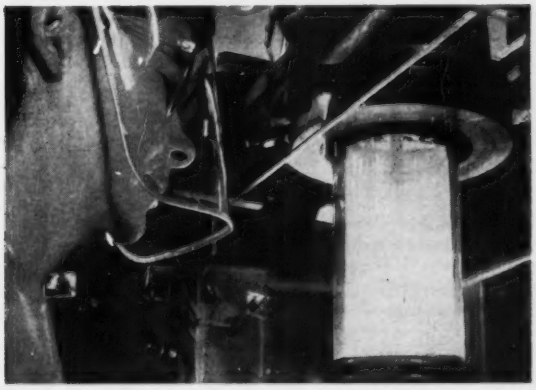
The Fording Test *is typical of the tough environmental tests imposed upon advanced electronic equipment designed and produced by Hughes Fullerton engineers.*

in the dark

TARAN (Tactical Attack Radar and Navigator) is typical of the important new electronic systems developed by Hughes—in an atmosphere famed for its engineering orientation.

Hughes engineers have designed this system to enable pilots to fly blind at very low altitudes in any kind of weather—and actually deliver any kind of armament at tactical targets.

TARAN's amazing abilities are based on several major electronic advances developed by Hughes engineers: A radar system with several times the range and azimuth resolution of current radars. An Automatic Navigation and Display System which pinpoints position continuously and automatically corrects for any navigational deviations. A unique terrain clearance indication warns the pilot of any obstacles when flying at low altitudes. A radar antenna utilizing electronic rather than mechanical lobing.



Molten Ladle *of silicon is watched during first step in the precise manufacture of Hughes semiconductors, just one of the Hughes commercial activities.*

Other Hughes activities provide similarly stimulating outlets for creative engineers. A few representative project areas include: advanced data processing systems, molecular electronics, advanced 3-D surface radar systems, space vehicles, nuclear electronics, ballistic missiles, infrared devices—and a great many others. The commercial activities of Hughes have many interesting assignments open for imaginative engineers to perform research, development, manufacturing of semiconductors, electron tubes, and microwave tubes.

Whatever your field of interest, you'll find Hughes' diversity of advanced projects gives you widest possible latitude for professional and personal growth.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	Equipment Engineering
Infra-red	Microwave & Storage Tubes
Solid State Physics	Communications Systems
Digital Computers	Inertial Guidance
Reliability & Quality Assurance	Field Engineering
Systems Design & Analysis	Circuit Design & Evaluation

Write in confidence to Mr. R. A. Martin
Hughes General Offices, Bldg. 6-B8, Culver City, Calif.

Creating a new world with ELECTRONICS

HUGHES

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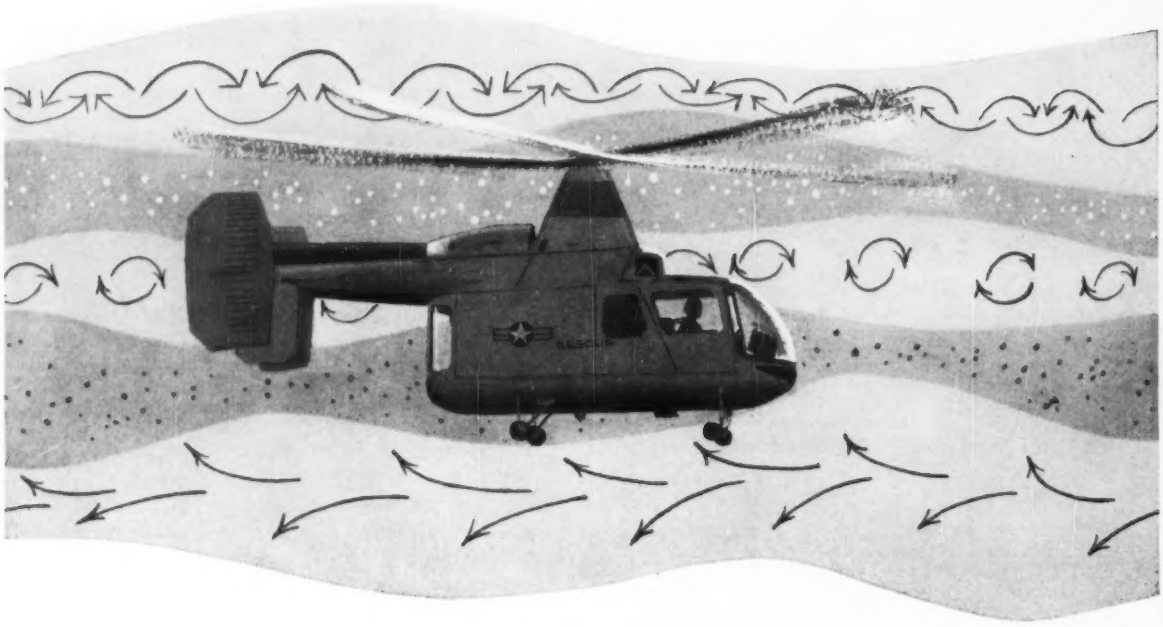
HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California; Tucson, Arizona



sta-bil'i-ty

Poised in recovery or skimming straight and level — in any attitude — stability augmentation from American-Standard steadies the Kaman H-43B Huskie. This USAF rescue helicopter adds one more high performance vehicle to the growing list of applications for our subminiature inertial components. In aircraft — the F-106, in missiles — the Terrier and Tartar, and in submarines — the Polaris class, American-Standard, Military Products Division supplies gyros fundamental to accurate positioning and control.*

Company sponsored development in the Military Products Division has produced a family of gyroscopes, accelerometers and miniature components whose quality, performance and reliability make them unique in the field of navigation and stabilization systems.

Opportunities for Engineers

Winning this degree of acceptance has created new career opportunities in advanced design, production and applications engineering. American-Standard, Military Products Division, Norwood, Massachusetts.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

American-Standard
MILITARY PRODUCTS DIVISION

Trade Literature...

Electric Components Brochure . . .

A 14-page magazine-size brochure, "The Story Behind Corning Electronic Components," describes methods of making products that include resistors, capacitors, trimmers, delay lines, level switches, metallized components, printed circuits, and microcircuitry wafers. The brochure, aimed at members of technical management, is available by requesting CEB-1-59 on company letterhead from **Corning Electronic Components, Corning Glass Works, Bradford, Pa.**

"How to Read Your Business Records" . . .

This brochure helps businessmen who have little or no understanding of bookkeeping; it explains in digest form how to understand the six basic sections of their business records: sales, expenses, accounts receivable, accounts payable, profit or loss statement, and financial statement. It suggests what to look for among these figures, how to recognize danger signs, and what to do about them. **The Ideal System Co., 2437 W. Pico Blvd., Los Angeles 6, Calif.**

Radioactivity Surveys . . .

A comprehensive technical report on "Environmental Radioactivity Surveys" discusses the nature and purposes of such a survey, the type of nuclear operations that require them, the classes of samples analyzed, and radio-analytical methods employed. **Controls for Radiation, Inc., 130 Alewife Brook Pkwy., Cambridge 40, Mass.**

"General Plate Products" . . .

A revised brochure, "General Plate Products," third edition, 10 pages, describes the scope of the manufacturer's line including solid and clad base metals, solid and clad precious metals, thermostat metals, electrical contacts, and the company's "industrial" metals including profile rolled strip, manganese age-hardening alloys, copper-cored glass sealing alloy wires, solid and clad reactor metals, clad metals for semiconductor applications, and aluminum-iron alloys. The last three categories of industrial metals and copper-base Aliron are included for the first time in the third edition. **Texas Instruments Inc., Metals & Controls Division, 34 Forest St., Attleboro, Mass.**

Catalog on Rolling Steel Doors . . .

Fourteen types of rolling steel doors to meet every industrial and commercial requirement are described in catalog G-60. Detailed are features and engineering specifications of standard hand, mechanically and power-operated doors, both Underwriters' labeled and nonlabeled types, including tables of clearance dimensions. **Building Products Division, R. C. Mahon Co., E. 8-Mile Rd., Detroit 34, Mich.**

Magnetic Tape Recorder Booklet . . .

The third generation in the *100* Series of Ampex instrumentation magnetic tape recorders is covered in a 20-page booklet on the FR-100B. **Ampex Data Products Co., 934 Charter St., Redwood City, Calif.**

Electronic Instruments Catalog . . .

This catalog describes and illustrates instruments for electronic, biological, and chemical measurement and control. Specifications and performance data are included for the complete line of instruments, including the newest additions: Model *603* differential electrometer amplifier, *250* static meter, and Model *240* regulated high-voltage supply. Schematic diagrams and application circuits, as well as basic information on electrometers and micromicroammeters, are included in the 32-page reference catalog for advanced research and production instrument users. **Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.**

"Painting vs. Molding in Color" . . .

The booklet shows that the painting of polystyrene and other thermoplastic parts often permits substantial savings when compared with molding in color. Test data show that painting with new patented acrylic butyrate coatings provides superior surface abrasion properties to that of molded polystyrene plastic and to that of commonly used acrylic automotive finishes. **Bee Chemical Co., Logo Division, 12933 S. Stony Island Ave., Chicago 33, Ill.**

Brochure on Copper-Plated Steel Wire . . .

Detailed information on the use of Copperply for bare and insulated communications wire, rural distribution wire, drop wire, guy and messenger strand, overhead ground wire, lashing wire, aircraft antenna, masonry tie wire, hose reinforcement, tinsel, decorative jewelry, and critical electronic applications is described in Bulletin 203. Specifications are listed for gauge tolerance, scope and grade, elongation, resistivity, torsion, bending, wrapping, and ferroxyl tests. Properties tabulated include sizes vs. copper thickness, breaking load, weight, and resistance.. **National-Standard Co., Niles, Mich.**

(*Continued on page 62A*)

sta-bil'i-ty

A note for talented engineers:

Stability at American-Standard is the result of dynamic action and can mean a lot in terms of professional growth at the expanding Military Products Division.*

The logical growth from the projects already in the house extends a tremendous challenge. And, the "off-site" advantages are as stimulating as the in-plant creative environment.

To repeat them just for the record: Residential Boston suburb, excellent benefits, relocation assistance, company-sponsored education, and the wide cultural and recreational attractions of the area.

Footnote: Excellent salaries for qualified engineers in both our Systems and Components Departments. Please submit resume to Mr. J. A. Reardon, Employment Manager, American-Standard Military Products Division, Norwood, Massachusetts

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American-Standard
MILITARY PRODUCTS DIVISION

Significant Sample OF SUPPORT FACILITIES AT

Automatic Component Tester, designed and developed by Univac Test Laboratory expressly as an aid to statistical analysts and quality control engineers, reads and records data at the rate of one parameter per second. Performing the same operations by manual methods requires an average of 30 seconds and is far less reliable.

Univac® Automatic Component Tester aids engineers in developing ultra-reliable military computers

The emphasis on reliability at Remington Rand Univac places challenging demands on statistical analysts and quality control engineers. The crucial role of the tens of thousands of small components which go into miniaturized assemblies create a special problem. Vast numbers must be tested to provide data necessary to assure meeting the exacting "acceptable quality level" requirements for a highly reliable product. Accuracy and uniformity of component evaluation measurements are, of course, vital.

With the development of the Automatic Component Tester, a method has been found to furnish data on significantly larger samples than were previously practical and to assure far more reliable results than through manual methods.

The ACT evaluates components at a rapid rate, automatically applying various tests, presenting the results in digital form and eliminating the factor of human error. It will also make dynamic tests so that instantaneous readings can be recorded as values change within preset limits.

Systems Analysts using the Univac Scientific Computer analyze data produced by Automatic Component Tester. Tester records readings in digital form on punched tape, ready to be fed into computer, or in numerical form on automatically operated electric typewriter.

This is one example of how Remington Rand Univac supports the activities of engineers in statistical analysis and quality control. Every effort is made to create an environment where you can do your most effective work. This is the type of environment which fosters your professional advancement. If you are thinking of changing positions, or would consider a change, be sure to investigate our opportunities.

IMMEDIATE OPENINGS

There are immediate openings at several levels of responsibility for men with degrees in Engineering or Science and a minimum of two years' experience in electronics or related fields. The cost of relocation is paid and liberal employee benefits are provided.

SPECIFICATIONS ENGINEERS
COMPONENT ENGINEERS
CIRCUIT ENGINEERS
COMMUNICATIONS ENGINEERS
ELECTRONIC FIELD ENGINEERS
ENGINEER WRITERS
QUALITY CONTROL ENGINEERS
RELIABILITY ENGINEERS

If you have applicable experience, we invite your inquiry. All correspondence will be handled promptly and in complete confidence.

Please send a complete resume of your education and experience to:

R. K. PATTERSON, Department R-3

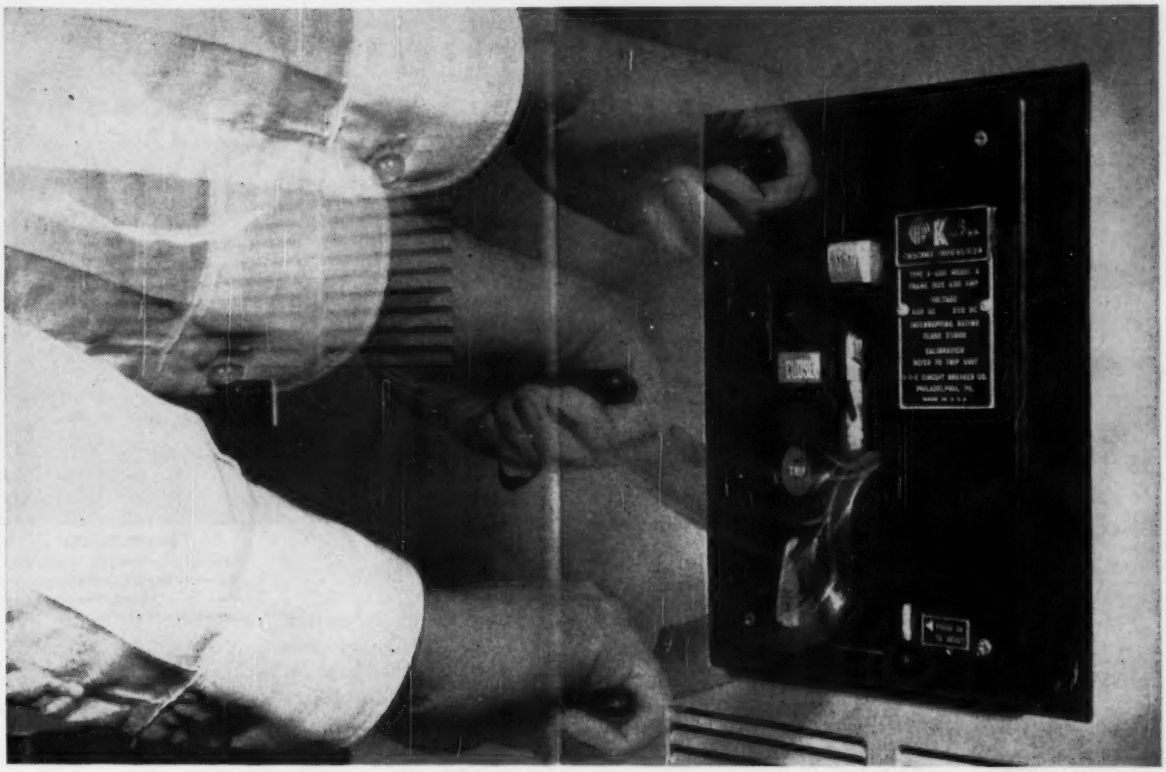
Remington Rand Univac 2750 West Seventh Street, St. Paul 16, Minnesota

DIVISION OF SPERRY RAND CORPORATION

All inquiries regarding openings at our other laboratories should be addressed to:

F. E. NAGLE—Department R-3,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
1900 West Allegheny,
Philadelphia 29, Pennsylvania.

R. F. MARTIN—Department R-3,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
Wilson Avenue,
South Norwalk, Connecticut.



I-T-E started a revolution in 1957 when it introduced the completely new K-Line circuit breaker with stored energy closing. Today it is still the most advanced circuit breaker for low voltage switchgear you can buy.

ONLY I-T-E 600 V. SWITCHGEAR GOES BEYOND STORED ENERGY

GIVES YOU ADVANCES NO OTHER GEAR OFFERS

Closed door disconnect. A real safety feature. Operator can rack breaker out to either test or disconnect position without opening door. Prevents cluttered aisles from open doors and protruding breakers. And keeps breakers clean when they are disconnected.

Expanded range trip. I-T-E breakers can grow with your loads. Each trip device has roughly three to four times the range of conventional devices. Saves cost and downtime that replacement would demand. Easy to adjust. Calibrated directly in amperes.

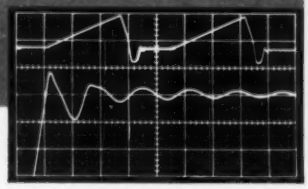
You pay no more. That's right. With all these extra advances I-T-E low voltage switchgear costs no more. Send for detailed descriptive Bulletin 6004-C. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

F. E. NAGLE—Department R-3,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
1900 West Allegheny,
Philadelphia 29, Pennsylvania.

R. F. MARTIN—Department R-3,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
Wilson Avenue,
South Norwalk, Connecticut.

NEW DC-to-30 MC DUAL-BEAM Tektronix Oscilloscope with Independent X and Y Deflection



SWEEP DELAY
Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform.

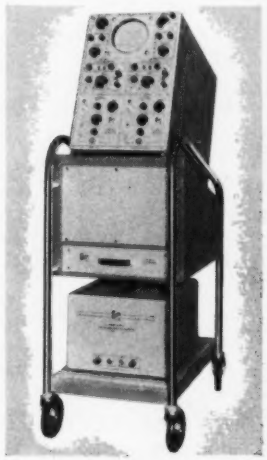
TYPE 555

Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope.

Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in type to facilitate instrument maintenance.

With one time-base generator functioning as a delay generator, the start of any sweep generated by the other can be held off for a selected time interval with a high degree of accuracy. Both the original display and the delayed display can be observed at the same time. The "triggered" feature can be used to obtain a jitter-free delayed display of signals with inherent jitter.

Signal-handling versatility is provided by nine available types of plug-in preamplifiers, any combination of which can be used in the two fast-rise vertical channels. In addition to the many application areas opened with Tektronix plug-in preamplifiers, a three-channel or four-channel display is available through use of the time-sharing characteristics of Type C-A Dual-Trace Units in one or both channels.



Characteristics

INDEPENDENT ELECTRON BEAMS
Separate vertical and horizontal deflection of both beams.

FAST-RISE MAIN VERTICAL AMPLIFIERS
Passbands—dc-to-30 mc with Type K Units.
Risetimes—12 mμsec with Type K Units.
All Tektronix Plug-In Preamplifiers can be used in both vertical channels for signal-handling versatility.

WIDE-RANGE TIME-BASE GENERATORS
Either time-base generator can be used to deflect either or both beams.
Sweep ranges—0.1 μsec/cm to 12 sec/cm. 5 x magnifiers increase calibrated sweep rates to 0.02 μsec/cm.

SWEEP DELAY—Two modes of operation.
Triggered—Delayed sweep started after the delay period by the signal under observation.
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Trade Literature

(Continued from page 57A)

Film on Welding Electrode Selection . . .

Following a well-established road in the sponsorship of educational motion pictures for welding fabricators, vocational schools, metal societies, and the metal working industry in general, Hobart Brothers Co. has produced a 25-minute, 16-mm film, titled "Arc Welding Electrode Selection," that tells of basic factors which are important for correct electrode selection. It outlines a step-by-step procedure that covers base metal identification, welding currents, welding positions, thickness and shape of base metal to be welded, joint design and fit-up, service conditions, production efficiency, and environmental and job conditions. Reservations for a showing of the film may be made with the film library, **Hobart Brothers Co., Troy, Ohio.**

Assembly Fastener Brochure . . .

This special-purpose brochure provides design engineers and other technical men with information on a new line of self-retaining assembly fasteners. A wide range of metal fasteners for a variety of original equipment manufacturing, installation, and assembly operations is presented. **Robin Products Co., 27027 Groesbeck Hwy., Warren, Mich.**

Bulletin on Lifetime Drainline . . .

A 12-page illustrated bulletin on the new Pyrex Brand lifetime drainline system for disposal of corrosive wastes contains product and property data, information on making joints and hanging, and a complete list of available fittings, as well as schematic drawings and tables. Bulletin PE-30 is available on request from the Plan Equipment Sales Department, **Corning Glass Works, Corning, N. Y.**

Digital Magnetic-Tape Recorder/Reproducer Brochure . . .

The brochure describes the *5-681* digital tape recorder/reproducer transport, which operates at speeds up to 30 inches per second, and the *5-682*, a high-speed transport that operates up to 150 inches per second. Both are designed to meet a broad range of computer, industrial, military, and laboratory requirements. A detailed description of operating charcteristics and specifications for both units are included. Bulletin 1618 may be obtained from **Consolidated Electrodynamics Corp. 360 Sierra Madre Villa, Pasadena, Calif.**

Compressor Bulletin . . .

Six-page Bulletin 92 on the Cooper-Bessemer *DM-125* packaged compressor, 300-hp class, reviews the need for small horsepower, heavy-duty integral engine-driven compressors specifically designed for field gathering service. Power unit and compressor cylinders used in the packaged construction of the *DM-125* are discussed, along with operating characteristics. Articulated connecting rod construction and crosshead and guide assembly, as well as over-all dimensions, are illustrated. **The Cooper-Bessemer Corp., Mount Vernon, Ohio.**

"Large Single Metal Crystals" . . .

This 11-page Bulletin 102 entitled "Large Single Metal Crystals," describes standard specimens, as well as unusual shapes and special crystal orientations. Write to **Flow Corp., 85 Mystic St., Arlington 74, Mass.**

Concrete Pour Units Catalog . . .

A catalog of prewired recessed lighting fixtures designed specifically for use in concrete pour construction is available from Prescolite Manufacturing Corp. The fixtures are so engineered that wiring may be done either before or after concrete pouring. The brochure describes and illustrates the new series of factory-assembled fixtures and contains specification charts as well as housing-plan views. To obtain catalog CP-1, write to **Prescolite Manufacturing Corp., 2229 Fourth St., Berkeley, Calif.**

Semiconductor Aids . . .

A series of aids developed for those engaged in the design, development, production, and application of semiconductors, are presented in catalog form. These include high purity, elements, phase diagrams, "doped" alloys, and a chart of the physical properties of pure elements as used in semiconductors. These materials are available in microform spheres, dots, washers, ribbon, or wire tailor-made to individual requirements. **Anchor Alloys, Inc., 968 Meeker Ave., Brooklyn 22, N.Y.**

Leaflet on Direct Print Paper . . .

Kodak Linagraph direct print paper, a photographic material which provides an immediately visible record of certain oscillographic tracings, is described in a leaflet now available from Eastman Kodak Co. The photo recording paper yields an image without chemical processing and is capable of recording through a wide range of operating frequencies. It is manufactured for use in moving-mirror galvanometer oscillographs which employ an ultraviolet light source. Writing speeds of 100,000 inches per second are possible. For Pamphlet P-40, write to **Eastman Kodak Co., Photo Recording Methods Sales Division, Rochester 4, N.Y.**

(Continued on page 66A)

NEW ALUMINUM SUBSTATION UNITS

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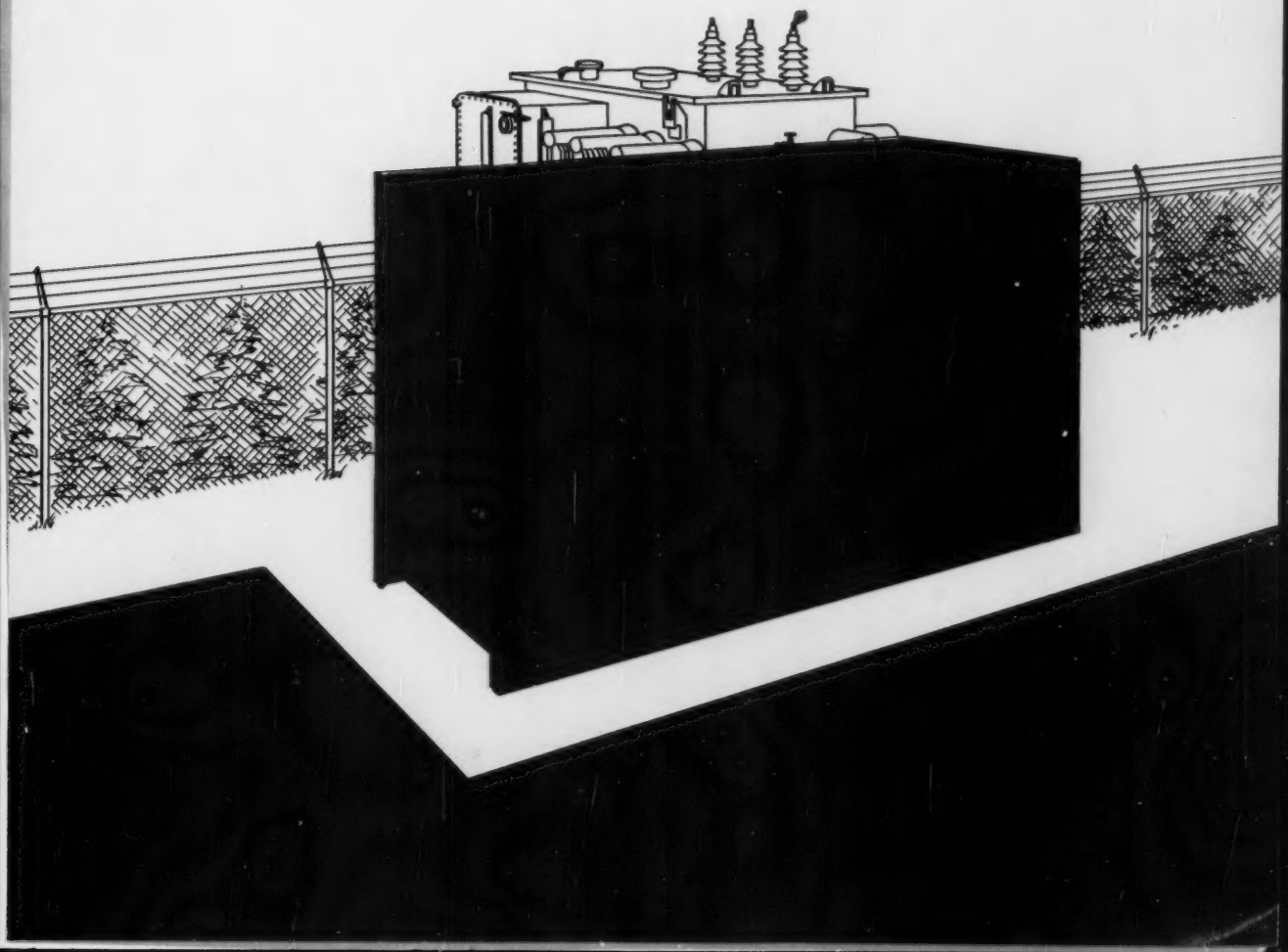

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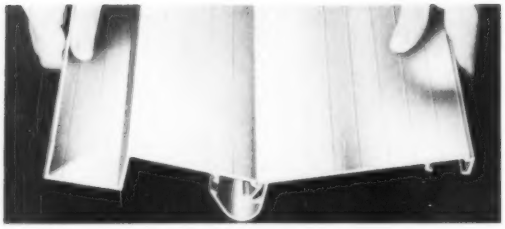

Panels for Aluma-Clad switchgear housing snap together so that joints between them are water tight. Extruded aluminum panels interlock to form reinforced sections.

Bolted-on rear panel sections are easily removed by *one man* without use of a crane. Each switchgear cubicle can be inspected individually. Ventilation in this region is increased by using the labyrinth cross-section of the aluminum extrusions to pass filtered air up through the bottom and out the top. This increased cooling of the bus compartment keeps the operating temperature within maximum limits even during peak load periods on hot days.

Developed by Allis-Chalmers and Reynolds engineers, this new aluminum substation unit offers many important advantages in electrical installations. Extruded aluminum sections that interlock to form structurally reinforced panels are used in construction to reduce labor costs, provide strength and rigidity. The station flooring also utilizes aluminum sections that interlock to provide a neat, clean installation.

Aluminum will never rust, therefore these units will never need protective painting. They'll resist corrosion in salt air and contaminated atmospheres.

The bright natural sheen of aluminum is a lasting one, too. That means these aluminum-clad substations will add real beauty to your installation, beauty that lasts.

And because aluminum is lighter in weight, shipping and installation costs can be lower. Roof-top installations, especially, can be simpler, less expensive with the new Allis-Chalmers switchgear units.

Allis-Chalmers new aluminum-clad outdoor substation units are an important engineering achievement in electrical equipment design—an achievement which means lower costs, more lasting beauty for utility and industrial substation installations. Reynolds is proud to have played a role in this important development, providing both aluminum and aluminum know-how. For details on any electrical equipment using aluminum enclosures, contact your nearest Reynolds Sales Office or write *Reynolds Metals Company, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

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Trade Literature

(*Continued from page 62A*)

Selector Chart for Resins, Bonding Agents . . .

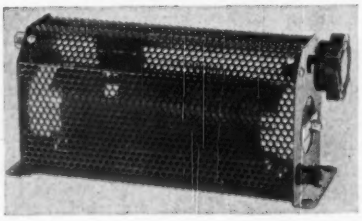
Bulletin 121, containing selector charts for potting compounds, coatings, foams, and bonding agents, is available from Plastic Associates. The selector charts are designed to help the electronic engineer, designer, or packaging specialist to pick the exact resin that will best fit his needs. Definitions are provided for such terms as casting, encapsulation, impregnation, and coating. The charts offer hard, semirigid, and flexible formulations for each of these processing applications. A similar breakdown is given for foams. **Plastic Associates, 185 Mountain Rd., Laguna Beach, Calif.**

Switch and Relay Catalog . . .

Electrical switches and relays are described in an illustrated 4-page brochure. Pictures include miniature, subminiature, appliance, open blade, general purpose, metal clad, machine tool, and Acro-Lite. **Acro Division, Robertshaw-Fulton Controls Co., P. O. Box 449, Columbus 16, Ohio.**

Caged Jagabi Rheostats Bulletin . . .

Caged Jagabi rheostats insure maximum safety to the operator. Because their sturdy protective metal cages completely enclose live and hot parts, these rheostats are equally suitable for use in shops, testing departments, and laboratories. The new type of perforated material allows



50% more open area than older types thus affording more efficient cooling. An additional convenience is in the new cages themselves which can be added in the field as well as in the factory. Mounting dimensions of the caged rheostats are the same as for the open rheostats, varying only in the slight increase in slider height. For complete details and information write for Bulletin 41-7. **James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.**

"Dust Topics" . . .

This pamphlet discusses methods of collecting and measuring aerosols and dusts from ducts and stacks. Detailed instructions on standard methods for evaluating dust concentrations in work areas also are presented. **Gelman Instrument Co., P. O. Box 86, Chelsea, Mich.**

Cryogenic Properties Card . . .

A folding pocket card, Form 1341, presenting in tabular form the physical property equivalents of some cryogenic fluids gives boiling and melting points; critical temperatures and pressures; volume, mass, and thermal equivalent; and conversion factors. The cryogenic fluids treated are those most useful to engineers in the chemical and missile industries. Distribution Department, **Linde Co., Division of Union Carbide Corp., 30 E. 42nd St., New York 17, N.Y.**

Vibration Meter Bulletin . . .

Model *T-1A* vibration meter, designed for accurate measurement of the velocity, displacement amplitude, and acceleration of vibration, is described and illustrated in a bulletin covering the battery-powered *T-1A's* specifications and applications. **Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc., 10201 Westheimer, P. O. Box 22187, Houston 27, Texas.**

"Keep It Clean!" . . .

The 6-page, gatefold bulletin describing materials to help draftsmen clean and protect drawings lists order numbers and prices for cleaning aids and protective spray marketed by **Keuffel & Esser Co., Adams and Third St., Hoboken, N. J.**

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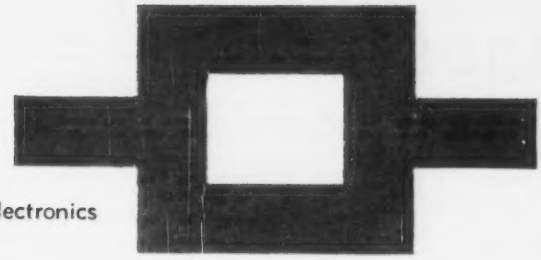

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PRODUCTION TEST ENGINEER: Electrical graduate, with one to three years' experience as a production test engineer in a commercial electronics company. Must understand the principles of operation of all basic types of electronic test equipment. Will supervise the construction, maintenance and utilization of electronic test equipment; design test equipment; set up test procedures, etc. Salary, to $7500 a year. Location, Newark, N.J. W8535.

SALES ENGINEER: R & D, electrical, with knowledge of electronic systems and about three to five years' successful military sales experience. Should hold or have had military clearance. Responsibility will be to acquire R & D contracts in prescribed product or research areas. Extensive travel. Should be willing to relocate in future. Salary open. Headquarters, New York Metropolitan area. W8534.

ELECTRONIC SALES ENGINEER: Degree desirable but not required, for sales activity to aircraft and electronic industries. Products include relays, inverters, flashers, etc. Territory, East Coast. Headquarters, New Jersey Metropolitan area. W8530.

RADIO COMMUNICATIONS ENGINEER: Electrical graduate, with experience in the design of radio transmitting and receiving stations; also in micro-wave as well as low and medium high frequencies is desirable. Must be willing to accept foreign field assignments. Company pays placement fee. Headquarters, New York, N.Y. W8505.

SUPERVISORY UTILITY PERSONNEL: With experience in modernization and extension of power and distribution systems, preferably in foreign fields. (a) Estimating and Engineering Supervisor covering line extensions, circuit improvements, etc., including conversion to 230 volt distribution. (b) Dispatching and Operation Supervisor, to take charge of system operations, dispatching, switching, relaying, communication in transmission and distribution. (c) Metering and Service Supervisor, to take charge of meter inspection, testing, repair and installation. (d) Procurement and Warehouse Supervisor, with at least 15 years experience covering electrical utility construction supplies and equipment. Salary, $12,000-$14,000 a year, plus housing. U.S. citizens. Location, Far East. F8500.

ELECTRICAL ENGINEERS: (a) Chief Electrical Engineer, graduate, with 15 years in responsible design positions with minimum of five years in responsible charge of design of major hydro-electric power stations and transmission station. Will head up a section of engineers in hydraulic and hydro-electric department. (b) Assistant Chief Electrical Engineer, graduate, with ten years in responsible design positions with minimum of five years in charge of design of major hydro-electric power stations and transmission systems. Permanent staff positions. Salaries open. Location, New York, N.Y. W8499.

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ELECTRICAL ENGINEERS: With a minimum of five years' experience in public utility distribution, transmission, metering and relaying. Spanish and asset but not essential. Good living conditions. Salary, to start, $13,000 a year. Location, South America. F8485.

CHIEF ELECTRICAL ENGINEER: Master's degree in electrical engineering, with eight to ten years' experience in the design and development of synchros, servo motors, motor tachometer and resolvers. Salary $20,000 a year. Location, New York, N.Y. W8481.

DEVELOPMENT ENGINEER: Graduate physicist, electrical or chemical engineer, with extensive experience in solid state field with special emphasis on areas of semi-conductors, transistors, rectifiers, etc., for a company which manufactures and designs transformers, reactors, filters and windings for the electronic industry. Will give consideration to an applicant on a consulting basis. Agency fees, relocation expenses, etc., open to negotiation. Location, upstate New York. W8478.

SENIOR ELECTRICAL ENGINEER: Graduate, with a minimum of five years' radar experience, for the design and development of pulse, video, audio circuits, DC amplifiers; assist in production test of radar simulators; supervise junior engineers and technicians. Salary, $8500-$10,400 a year. Location, Metropolitan New Jersey. W8469(a).

SALES SPECIALIST: M.S. in electrical engineering, with a minimum of two years' experience in digital computer circuitry, preferably magnetic circuit logic, to sell multiaperture ferrite magnetic devices and circuits. B.S. degree in electrical engineering will be considered if there is a corresponding increase in experience. Desirable to have an understanding of basic square loop magnetic material properties, information storage techniques, shift registers, memory planes, computer programming and operation. Must be free to travel. Salary, area of $12,000 a year. Company pays placement fees and relocation expenses. Headquarters, western Pennsylvania. W8462.

ENGINEERS: (a) Electrical or Electronic Engineer, degree, with experience in development and design of pulse generator units (vacuum tube and solid state), pulse-forming networks and design and analysis of delay lines. Testing and evaluation experience desirable. Salary open. (b) Design Engineer, Capacitors, graduate electrical, with two to six years' experience designing capacitors or related electronic components. Will do basic design of film and wound capacitors consulting with fellow engineers to coordinate and improve designs. Salary, $7500-$10,000 a year. Company pays placement fees and relocation expenses. Location, western Pennsylvania. W8461.

ELECTRICAL ENGINEER: 40-55, to take charge of electrical design for firm of consultants on chemical plants and refineries. Must have experience in power, light, transmission and distribution, controls, etc. Salary, about $12,000 a year. Location, New York, N.Y. W8441.

TEST ENGINEER: Graduate electrical, with heavy transistor background; experience in testing military communications electronic equipment; preparation of test procedures. Plan tests and work with engineers in R & D labs. prior to equipment transfer to test department, etc. Responsible for incoming quality control. Salary to $15,000 a year, plus up to 15% of gross salary deposited for employee in pension plan annually. Location, lower Connecticut. W8424.

DEVELOPMENT ENGINEERS: Electronic, B.E.E., with two to five years' experience in following fields: Antenna system design, radar system design, microwave components or instruments design. Individual and close work with highly qualified engineering staff in applied and basic topics in electromagnetic radiation, radar and navigational microwave components, instruments and devices. Salary open. Company pays placement fee. Location, Rhode Island. W8420.

ELECTRICAL ENGINEER: B.S. in E.E. from recognized university, with a minimum of ten years' experience in electrical engineering investigations and studies involving additions, alterations, replacements and repairs for electrical installations and equipment including power generation, power distribution. Salary, $11,088-$15,000 a year. Location, Central America. F8397.

ASSISTANT OR ASSOCIATE PROFESSOR OF ELECTRICAL ENGINEERING: Ph.D. desirable. Interest in undergraduate teaching of primary importance. Salary, to $8200 a year. Location, South. W8384.

SALES ENGINEERS: For a new electronics division. (a) Sales Engineer, B.S.E.E., with a minimum of two years' electronic equipment sales engineering, with some design background. Must be able to meet and negotiate with top level-sub-contractor personnel of major prime contractors. Relationship with major prime contractors in Los Angeles area desired. Territory, West. (b) Sales Engineer, experience as above, except familiar with prime contractors in New York, Philadelphia and Washington Area. Territory, East. (c) Sales Engineer, experience as above, except familiar with prime contractors in Cleveland, Buffalo, Syracuse, Rochester, and Boston area. Territory, Northeast. (d) Sales Engineer, experience as above, except familiar with prime contractors in Milwaukee, Chicago and Minneapolis area. Territory, Midwest. Salaries, $8000-$9000 a year plus expenses, but will consider higher salary if experience warrants. W8369.

PROJECT ENGINEERS: Electrical graduates, with seven to ten years' experience in digital computer or logic design analysis and logic work on indicating and controlling instruments. Salary, about $12,000 a year. Company pays placement fee. Location, New Jersey. W8330.

SALES ENGINEER: B.S.E.E., or equivalent, to 45; with four years' experience selling electronic components. Must have sales experience. Duties will include selling electronic components to industry in North Illinois, and Iowa, ¾ of territory will be in Metropolitan Chicago; travel, home week-ends, car required. Employer will negotiate the fee. Salary, $9,000-$9500 a year. C7909.

San Francisco Office

SALES ENGINEER: Electronic background, 20-40. Trainee or experienced salesman with knowledge of names, applications and use of industrial components and some familiarity with electronic circuitry and ability to deal with technical people and purchasing agents of o.e.m. buyers of electronic components. For manufacturer's agent covering San Francisco Bay Area. Base salary $5400-6000; potential $12,000. Sj-5003

SENIOR ELECTRONIC ENGINEER: EE, 28-40. Must have several years design experience, minimum of two years transistor design, pulse and switching circuits preferred. Must be able to supervise people and maintain complete control of a program, from inception to prototype production. Work with minimum of supervision. Background must show ability to assume responsibility. For design programs involving transistorized electronics and electromechanical devices. To $12,000. San Francisco Peninsula. Sj-5001

DESIGNER: EE, to review electrical and electronic requirements on present design, evaluate components, determine feasibility of changes in production design from electrical and producibility standpoints; improve existing design, formulate electric standards and specifications, supervise electric schematic and wiring diagram and printed circuit drafting. Should have some experience in similar capacity and should have some circuit design background. Salary open. San Francisco Peninsula. Sj-4997

ELECTRONIC INSPECTOR: Graduate of electronic technician course, or two years college in electrical engineering. Minimum of two years experience as electronic technician in inspection. To inspect electronic and electromechanical subassemblies, assemblies and components; for instrument manufacturer. Salary open. San Francisco Peninsula. Sj-4983

PROJECT DESIGNER: Physicist or EE. qualified by recent and substantial experience to handle complete projects on design development, production and preparation of manuals on nuclear instrumentation. Should have basic knowledge of circuitry, techniques, application of scientific instruments, such as spectrometers, ionization chambers, photomultipliers, transducers, electromagnetic; work from client's specifications, modifications of standard lines of development of new products. For a manufacturer. $8400-14,400. San Francisco East Bay. Sj-4979

SALES TRAINEE, ME, EE, ChE, young. Recent graduate or one to two years working experience with aptitude, desire and qualifications to enter into an industrial instrumentation sales training program involving process control and data handling instrument and equipment, direct reading, recording, actuating, or control of the electrical, mechanical, hydraulic or electronic type. For branch office of national manufacturer. Two to six months training in Pennsylvania. $6000-6600 and car, profit sharing and expenses. San Francisco headquarters. Must be willing to accept promotional transfer to other West Coast office. Sj-4975

TEST ENGINEER: EE, young. Qualified to establish and administer test procedures and data for application, specifications and safety of electric circuit breaker equipment, such tests as high voltage, heavy current, 60-cycle impulse, temperature, life, mechanical. Able to report and evaluate result of such tests. For manufacturer. $8400-10,800. Los Angeles. Sj-4970

SALES APPLICATION ENGINEER: EE, under 40. Desirably with five years of experience handling application of circuit breakers including preparation of proposals, client contact and pricing for a manufacturer's branch office. $6500-8800 base. Los Angeles Headquarters. Sj-4969

ELECTROMECHANICAL DESIGN: EE (Electronics preferred) degree or equivalent experience, any age and one to two years experience on design; capable of electromechanical design. For work on instruments, process control equipment for plants and lab. For manufacturer. $6000-9400, depending on experience. San Francisco East Bay. Sj-4968

SALES ENGINEER: EE, with minimum of two years electronic equipment sales engineering with some design background. Must be able to meet and negotiate with top level subcontract personnel of major prime contractors. Relationship with major prime contractors in Los Angeles desired. $8000-$9000 year plus expenses, or higher depending on experience. West. Sj-4960-N

SALES ENGINEER: EE preferred, in "thirties", with some sales experience to call on steel mills, paper plants, research labs, railroads, general industry; for carbon manufacturer. $7000-8000 per year plus expenses and fringe benefits. Headquarters San Francisco Bay Area; location seven Western States (travel 20-25% of time). Car required. Employer will arrange for interview. Sj-4955

DESIGN DRAFTSMAN: EE or equivalent. Experienced in design and drafting of industrial and commercial electrical installations; knowledge of feeders, main switchboards, electric machinery as used in oil, chemical plants, brewers, etc. For consultant. To $7800. San Francisco. Sj-4946

MAINTENANCE SUPERINTENDENT: Six to ten years experience on maintenance, construction, design or operation of water works facilities; or repair or installation of mechanical or electrical facilites, including pumps, electric motors and allied control mechanisms or plant production equipment. To direct maintenance and installation, repair and servicing of pumps, electric motors, automatic control equipment, automotive and heavy construction equipment, metal parts, small frame and concrete structures. Under manager of operation and maintenance. Must be citizen. $10,200-11,600. San Francisco East Bay. Sj-4945

(a) SENIOR ELECTRONICS ENGINEER: EE (MS desired), five to ten years electronics circuit design on transistors and vacuum tubes. $12-15,000. (b) ELECTRONIC OR JUNIOR ELECTRONIC ENGINEER: EE or equivalent, two to four years experience electronics industry with transistor and vacuum tube circuits. $6-10,000. San Francisco Peninsula. Sj-4942

DESIGNER, PLANNER: Graduate EE or equivalent. Must be well experienced on planning and design of electric transmission and distribution systems, relay systems and operation, application. Family housing available. One and one-half year contract. About $14,400. FAR EAST. Sj-4940

SUPERVISING OPERATOR: EE or ME, age open. Qualified by recent and substantial experience to operate and supervise operation of hydro-electric generating plant and distribution of electric power. Should be American with experience with General Electric or Westinghouse turbo generating equipment and qualified to provide superintendency of all personnel plus continuing contact with government administration. Must be able to pass an overseas physical and to provide substantial references and have liking for living in warm overseas country. $12,000 plus subsistence and housing. Transportation furnished. Sj-4937

DESIGNERS, DEVELOPMENT ENGINEERS: EE, physicist or math, young. Minimum three to five years experience design of power equipment, closed circuit TV, measuring equipment, military systems, autopilot circuit and electromechanical. Light aircraft commercial use. $7-12,000. Southern California. Sj-4934.

ELECTRICAL DESIGNER: EE, preferably with California Registration, young. Preferably for California State Registration, although an EE with some experience and EIT would be considered; also consider more seasoned man without registration with solid experience. Work is primarily designing electric distribution, circuiting and illumination for buildings plus some field work on electrical construction. For consulting engineering office. $9000-12,000. Santa Barbara County. Sj-4932

Men Available

STAFF ELECTRICAL ENGINEER, 40; B.S.E.E., P.E. Twelve years' supervision of design, manufacturing and top level planning experience with consultant, industry, and public agency. Background covers power, controls, instrumentation and electronics. Location desired: East. E-164.

PLANT AND FACILITIES ENGINEER: Diploma electrical engineering, 43. 17 years' experience as supervising engineer of industrial power generation and distribution, facilities and machine planning, installing, and maintaining. Location desired: Boston area. E-165.

San Francisco Office

GENERAL MANAGER OR SALES: EE. BusA, 48. Extensive background in general management, sales and sales management of industrial products both mechanical and electrical. Know financing, cost analysis, production control and sales for industrial company. Can handle people and get results. Want progressive company. $15-20,000. Prefer: San Francisco Bay Area. Home: San Francisco Bay Area. Se-391

DESIGNER OR FIELD ENGINEER: EE, 41. Four years design of instrumentation, radar circuitry, power supplies for manufacturer and six years field engineer in maintenance and instruction of radar for airborne fire control system manufacturer. Also six years weather observer. Salary open. Prefer San Francisco Bay Area. Se-289

SALES ENGINEER, 50. Electrical Engineer Professional License, California. Eight years manager on sales of transformers, circuit breakers, electronic equipment. Twenty-three years experience as apparatus engineer, system planning, instructor on radar and communications, electric equipment for manufacturers and utility and Navy. $12,000. Prefer Southern California. Home: Southern California. Se-182

DESIGNER, MAINTENANCE: EE, 31. Four years design, layout lighting, telephone, communications, distribution, field engineering and inspection, maintenance for consultants and calculator manufacturer. Two years installation, maintenance of elevators. $8100. Se-1800

PLANT ENGINEER: EE, 37. Eleven years varied industrial experience in design, construction, maintenance and planning of plant facilities. Good record with people, problems, unions and operations. $10,800. Prefer: San Francisco Bay Area. Home: Washington. Se-1684

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(Continued on page 76A)

Personnel Service, Inc.

(*Continued from page 75A*)

DESIGNER, PRODUCTION ENGINEER: EE, 33. Eleven years experience budget costs on new products, charge of sales and service, design, specifications for electronic products, missiles. $14,000. Prefer: U.S. Home: East. Se-386

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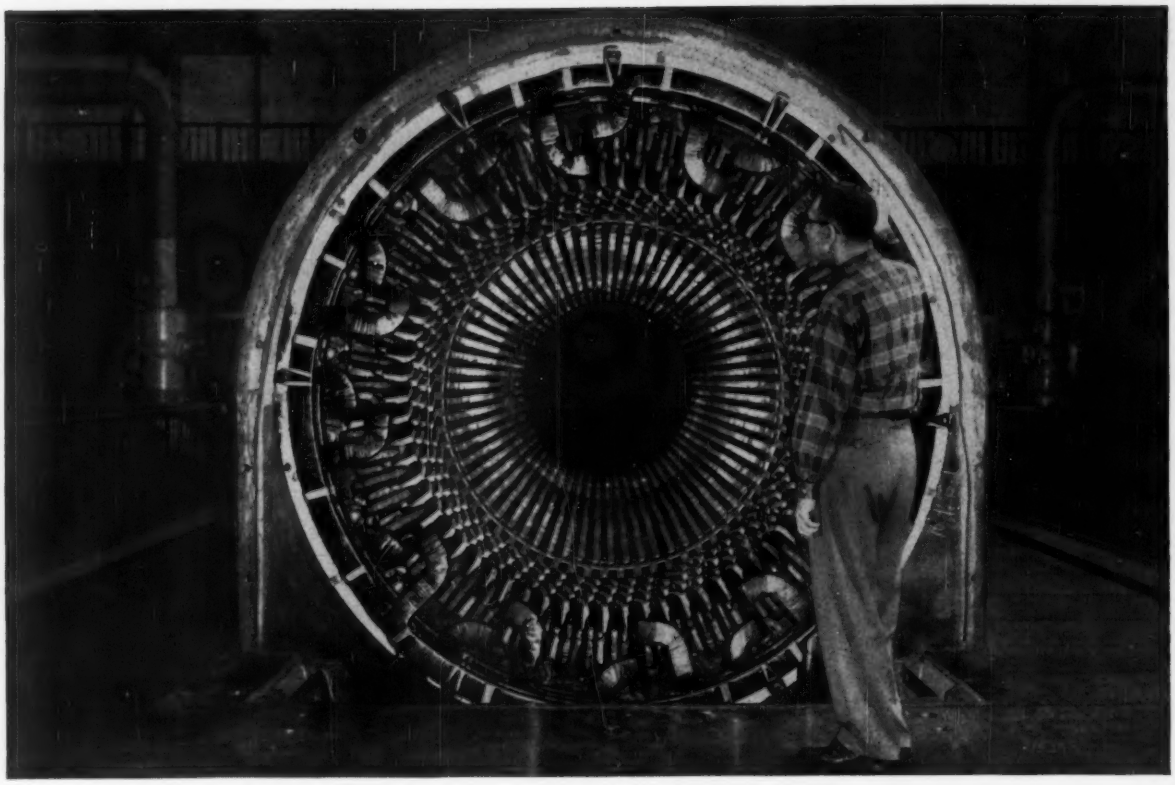

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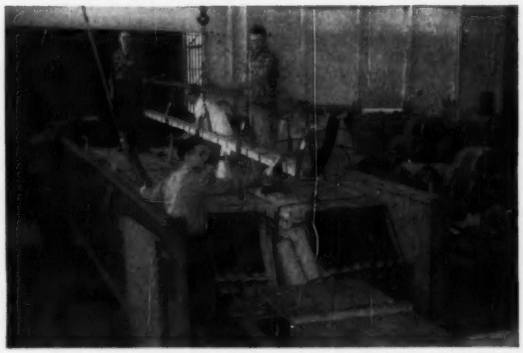

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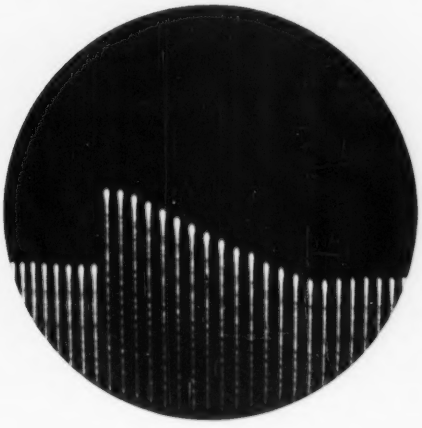

Oscillogram shows peaks of 60-cycle line voltage with sudden 2% change, and subsequent correction by regulator. Change is corrected in 12 cycles (0.2 sec.).

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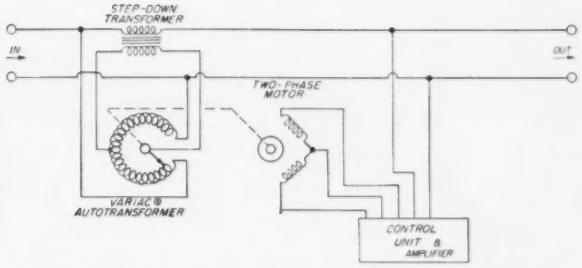
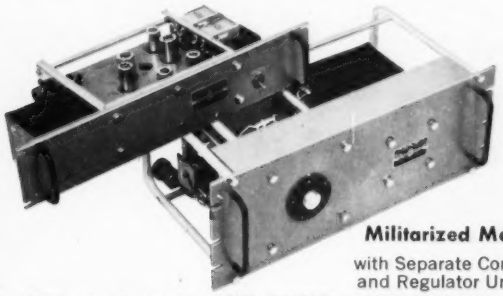


How it works — Any deviation from normal line voltage is sensed by the control unit. The resulting error voltage, amplified by a two-stage balanced amplifier, changes the firing angle of a push-pull thyratron circuit which in turn controls a low-inertia, two-phase servo motor. The motor adjusts a Variac® autotransformer which delivers a correction to the input line voltage through a buck-or-boost transformer.

The control-circuit thyratrons operate continuously and produce two, equal, in-phase motor voltages. Any line-voltage variation causes a proportionate change in phase angle between these two voltages. This change of phase produces a corresponding motor torque, causing correction to take place. Thus, smooth, truly proportional control is achieved, with consequent better accuracy, faster response, and less overshoot (see oscillogram) than is found in regulators using on-off methods.



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